GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

(Railway Board)

REPORT

OF THE

Commission of Inquiry to ascertain the Causes of the Accident to 565 Down Passenger Train between Jadcherla and Mahbubnagar on the Central Railway, on the night of 1st/2nd September, 1956.

BY

Shri Sunderlal Trikamlal Desai,

Judge, High Court,

BOMBAY

PRINTED IN INDIA BY THE GENERAL MANAGER,
GOVERNMENT OF INDIA PRESS, NEW DELHI, 1957

REPORT

of

THE COMMISSION OF ENQUIRY INTO THE ACCIDENT TO 565 DOWN PASSENGER TRAIN ON 1ST/2ND SEPTEMBER, 1956.

Accident

On the night of 1st September and at 00.39 hour of 2nd September 1956, Secunderabad-Dornachellam Passenger Train No. 565 Down, met with a serious and tragic accident between Jadcherla and Mahbubnagar Stations (Metre Gauge Single Line) of the Central Railway. While running from Jadcherla to Mahbubnagar, which are stations on the Secunderabad Division, at a speed of about 30 M.P.H., the train crashed on Bridge 229 across Pochani Nalla which is 7·62 miles from Jadcherla and 3·38 miles from Mahbubnagar. Bridge 229 is a small plate-girdered bridge of 20 feet clear span. The engine of the train with its tender and its first two coaches crashed into the Nalla. The engine came to a stop against the breached formation beyond the Mahbubnagar-end abutment in an inclined position with its front-end raised. The tender came to rest on the demolished portion of the abutment at the Mahbubnagar-end. It was lying almost on even keel. The first two coaches were immediately precipitated into the breach and smashed. The third coach which did not go down was partially damaged and its rear portion remained on the track. The other coaches were not derailed. 121 persons lost their lives and 37 persons were injured. Some of the dead bodies were picked up at a distance of about 2½ miles downstream of the bridge. The possibility of some more persons having met their death in this disaster cannot be ruled out.

Commission of Inquiry

By a Notification dated 10th December 1956, the Government of India in pursuance of Section 3 of the Commission of Inquiry Act, 1952 (LX of 1952), APPOINTED me as the sole member of this Commission which was being asked to:

"(i) consider the Report of the Government Inspector of Railways on the said accident, and take such additional evidence as may be necessary; and

(ii) state its findings as to the causes of the said accident and the person or persons, if any, responsible therefor."

Shri N. K. Mitra, retired Chief Engineer, Indian Railways, and Dr. K. L. Rao, Member (Design and Research), Central Water and Power Commission, were appointed as Assessors to assist and advise the Commission.

Report of the Government Inspector of Railways

The Government Inspector of Railways, Bangalore, started an inquiry into the matter on 4th September 1956.

He examined 82 witnesses and recorded their evidence. His Report was signed on 6th December 1956. He reached the conclusion that the cause of the accident was erosion and subsidence of the Jadcherla-end approach of the Pochani Nalla Bridge in consequence

of a sudden cloud burst over the catchment area. He also reached the conclusion "all the precautions that human ingenuity could think of had been taken but nature can always outwit human ingenuity and this occasion is one such". In his opinion the accident was solely the result of abnormally heavy rainfall. His finding amounts to this that what happened was due to an act of God or that this was an inevitable accident.

Inquiry at Hyderabad

I held two preliminary meetings with the learned Assessors on 20th and 22nd December in Bombay. The hearing of the Inquiry was commenced on 26th December 1956 in a Court Room of the High Court of Andhra Pradesh at Hyderabad which I was permitted by the Honourable the Chief Justice to use for the purpose of holding the same. The hearing was concluded at Hyderabad on 3rd January 1957. In the Inquiry, the Central Railway was represented by Shri Raja Ram, *ex*-Advocate-General of the Hyderabad High Court. Notices were published in a number of papers giving intimation to the public. On 25th December, the learned Assessors and I went to Mahbubnagar which is about 70 miles from Hyderabad and saw the site of the Bridge, the Pochani Tank and the P.W.D. Road which is downstream. Additional evidence of 20 witnesses, of whom 18 had already been examined by the Government Inspector of Railways, was recorded by me as I felt it necessary to do so. In response to letters of request sent by me, Shri L. Venkatakrishna Iyer, Chief Engineer, P.W.D., Government of Andhra Pradesh, Hyderabad, and Shri J. C. Hardikar, Additional Chief Engineer, Irrigation, P.W.D., Government of Andhra Pradesh, Hyderabad, have given evidence before me. Replies have also been received to a Questionnaire sent to Shri M. S. Thirumale Iyengar, Chief Engineer, Hirakud Dam Project. Data about rainfall was obtained from Meteorological Records of the Observatories at Poona and Hyderabad.

Before I give my summation of the evidence and formulate the questions that fall for determination, it will be convenient to state some introductory facts which are not in dispute or disputable.

Alignment

The general direction of the railway line between Secunderabad and Dronachellam is from North to South. The Alignment takes a turn near Jadcherla and between Jadcherla and Mahbubnagar, the railway line runs East to West. The alignment between Jadcherla and Mahbubnagar passes through a hilly terrain with stretches of paddy fields. The Secunderabad Division is the same as the former Nizam's State Railway before it was merged in the Central Railway in 1951. The Headquarters of the Division are at Secunderabad.

Pochani Nalla

Pochani Nalla winds its way in an amphitheatre of small hills to the north of the Railway bridge. The aggregate catchment area of this Nalla up to the bridge is 4·78 sq. miles. The terrain of the catchment is hilly and is fairly thickly wooded. About 9,000 feet

upstream from the Railway bridge the water from a catchment of 4 sq. miles was impounded to form a tank called Pochani-Kunta. The tank is near the village of Appanapalli and is very old. It appears that prior to the construction of the Secunderabad-Dronachellam section of the former Nizam's State Railway and till the end of 1953 the tank had for many years remained in an unrestored condition. The work of restoring the tank was taken up by the Irrigation Department, P.W.D., Hyderabad, in 1951 and completed in June 1953. There was for many years no impounded water in the Pochani Tank till its restoration before the monsoon of 1953. The capacity of the Tank was 13 million c.ft. From the Pochani Tank the Nalla starts as a broad stream gradually narrowing down and flowing through a fairly deep and winding channel up to the bridge. The Nalla takes a slight turn just before the bridge. After leaving the bridge the Nalla continues its course to the P.W.D. Road, which is about 1,700 feet on the downstream, and where it is bridged by a single 10 feet masonry arch. After leaving the road, the Nalla flows into the Namdar-Cheruvu which is a fairly large size tank. The average bed-slope of the Nalla from the Pochani Tank to the Railway Bridge is 1 in 100. The banks of the Nalla are of hard moorum which is not readily erodable.

Bridge No. 229

The construction of the 20 feet girder bridge across Pochani Nalla was completed in September 1916. The Abutments are of coarsed rubble stone masonry in lime mortar founded to a depth of 7 feet on hard moorum. The bridge is provided with coarsed rubble stone bed pavement in conjunction with curtain walls to protect the foundations against scour. The clear vent depth is 14·33 feet. The abutments are built with splayed wings and low return walls and pitching up to a height of 4 feet on the bank slope is provided on the upstream and downstream sides.

Meteorological Records, information about which was obtained from the Director General of Observatories, Poona, and the Director, Nizamiah Observatory, Begumpet, Hyderabad, show that the average annual rainfall at Mahbubnagar in the last 10 years is 36·64 inches. Intensities of 3 inches or more over 24 hours in these 10 years are:

RAINFALL	3·16 inches	..	in August, 1947;
	3·41 inches	..	in September, 1947;
	5·25 inches	..	in September, 1949;
	3·83 inches	..	in July, 1950;
	3·11 inches	..	in September, 1950;
	3·90 inches	..	in May, 1952;
	3·07 inches	..	in October, 1952;
	5·37 inches	..	in September, 1954;
	3·00 inches	..	in September, 1955.

The daily rainfall recorded at the Mahbubnagar Observatory on the 1st and 2nd September 1956 was 2·71 inches and 1·60 inches

respectively. Self-recording rain gauges to indicate the intensity of rainfall per hour are not provided at Mahbubnagar. Nor is any record of rainfall in the catchment area of the Pochani Nalla, which is about 4 miles west of Mahbubnagar, available. It has been suggested on behalf of the Railway that about 3 inches of rain must have fallen in one hour in the catchment area after 23.00 hours of the night of 1st September and a little before the accident.

Breaches at Bridge 229 on 1st August 1956

On 1st August 1956, a month before the accident under consideration, the bund of the Pochani Tank was breached and its impounded storage water unleashed. 13-million cubic feet of water forced its way to bridge 229, which was unable to accommodate the peak discharge on that occasion calculated by Dr. Rao to be about 7,000 cusecs. The railway track at the bridge was over-topped by about 3 feet of water and the approaches washed away to the extent of 25 ft. in length and 14 ft. in depth on the Jadcherla side and 31 feet in length and 16 ft. in depth on the Mahbubnagar side. That was at 2.30 in the afternoon of 1st August 1956. On that occasion timely action was taken by Shri Bheemadu, who was the Bridge Watchman on duty by day, to stop goods train No. 803 Down, which had already left Jadcherla and was proceeding to Mahbubnagar station.

Restoration work done after breaches of 1st August 1956

Restoration work of the approaches on both sides of the bridge were immediately commenced under the supervision of the Divisional Engineer and the Assistant Engineer. The approaches were made up with moorum and coal ash with 3% of boulders. Near the abutments sleeper cribs 3 feet square were erected. Through running of trains was restored on 2nd August 1956 after 25 hours of the breaches with a restriction speed of 'Stop Dead and Proceed at 5 M.P.H.' over the bridge and its approaches. Restriction of speed was relaxed by stages to 10 M.P.H. Non-Stop on 9th August 1956 and to 20 M.P.H. Non-Stop on 13th August. The speed restriction was fully removed on 21st August 1956.

Version on Shri Bheemadu, the night watchman on duty on 1st September 1956

Shri Bheemadu, who was on duty as day watchman on the 1st August 1956, was on night duty as watchman on 1st September 1956. The duty assigned to him was to watch bridge 229 at Mile 66/15-16 and bridge 233 at Mile 67/9-10, the distance between the bridges being 0·6 mile. He took up his watch at 6 P.M. Sometime thereafter he went to bridge 233. He was there for about half an hour and returned to bridge 229. He had seen the patrolman while he was going to bridge 233 and also while he was returning to bridge 229. When he returned, the water level at bridge 229 had risen to 3 feet. It is not possible to state with any precision the time he must have spent in going from one bridge to another and the time spent by him at bridges 229 and 233. But it has been ascertained that a goods train passed over bridge 229 at 21.00 hours on that night after he had returned to the bridge. It also appears that he started

his second beat after spending considerable time at bridge 229 and was at bridge 233 at about 11.30 P.M. After he had spent some time at bridge 233 on the second beat, he noticed a danger signal being given by the patrolman from Mahbubnagar side. He clamped detonators on the rails at Mile 67/10-11. He waited there for about 15 to 20 minutes to advise the patrolman of the fact that he had protected the track. The patrolman, who met him, informed him that serious damage had occurred to the railway embankment at Mile 68/5-12. He re-traced his beat showing a red light ahead of him. When he was at a distance of 4 telegraph posts (about 1,200 feet from bridge 229), he heard the crash of the passenger train. He ran to the site of the accident but was unable to cross over to the Jadcherla side. He detoured over the P.W.D. Road to the level crossing on the Jadcherla side and gave information of the accident to his gangmate at the gang quarters. There is no doubt that he was on duty and kept watch at the two bridges on the night of 1st September 1956.

Breaches of the embankment of bridge 229 on the night of 1st September, 1956

The actual accident has already been described. There was 2 to 2½ inches of rainfall (according to the Railway about 3 inches) in the catchment area of the Pochani Nalla during one hour after 11 O'clock of the night of 1st September. It appears that the level of the flood water at the bridge rose suddenly after Shri Bheemadu had left the bridge for the second time. It has not been possible to ascertain the exact level to which the flood water rose but I agree with the submission made on behalf of the Railway that water over-topped the railway line by about 6 inches to 1 foot and this caused serious breaches to the embankments on both the sides of the bridge.

Damage to bridge caused by the crash

There was considerable damage done to the Permanent-Way and the Bridge by the crashing of the engine and the two coaches when the accident occurred. Jadcherla-end abutment and the wing walls of the bridge were demolished up to about 2 feet from the bed level. Mahbubnagar-end abutment was destroyed up to about 5 feet from the bed level. The structure of the bridge before the accident has been ascertained to be sound and the masonry in the undemolished portion of the abutments has on examination also been ascertained to be sound. As to how exactly the engine and the first two coaches went down must remain a matter of theorising; but so much is clear that the left-hand girder of the bridge was found lying across the track with its leading-end 28 feet, 6 inches ahead of the engine. The right-hand girder suffered more extensive damage and was badly buckled. It was found 56 feet away from the track on the downstream side. The approach banks were damaged to the extent of 25 ft. in length and 15 ft. in depth on the Jadcherla side and 35 ft. in length and 16 ft. in depth on the Mahbubnagar side. The track over the damaged portion was completely smashed.

Ventway of bridge 229

One factor which features prominently in this inquiry and gives rise to a crucial consideration is that the waterway of Bridge 229 near Mahbubnagar was designed to accommodate a discharge of only 2,400 cusecs at a velocity of about 10 feet per second, the height of the flood section corresponding to this flow being 12 feet including the afflux. Hydrological calculations based on carefully selected data were made by Dr. K. L. Rao, one of the learned Assessors, and he expressed the opinion that the estimated maximum discharge in the Pochani Nalla on the night of the 1st September was in the order of 4,00 cusecs. This was far in excess of the capacity of the bridge and its approach banks to withstand the impact of the flood water. The fact that the approaches to the bridge had been restored on the 2nd August does not make any difference here because, as I shall have occasion to point out later on, the breaches to the approaches would have occurred even if they were in their old fully consolidated condition. It is also the case of the Railway that the impact of flood water on the night of 1st September was so great that it over-topped the Railway line and even the 40 year old consolidated embankments would not have withstood that impact. It has been admitted before me by two Senior Officers of the Central Railway, the Chief Engineer and the Divisional Engineer, that the ventway of a 20 feet bridge like No. 229 would not be able to resist the flow of water resulting from 2 inches of rainfall in one hour in a catchment area like that of the Pochani Nalla.

The Jangaon accident of 27th September 1954

On the night of 27th September 1954, there was a serious accident to an Express Passenger Train near Jangaon on the Secunderabad-Kazipet Broad Gauge Section of the Central Railway. The train crashed down Bridge 393 which was a girder bridge consisting of 4 spans of 20 feet each. The cause of the accident was ascertained, by the Government Inspector of Railways, to be scour at the bridge foundations. 136 persons were known to have been killed and a large number of persons were injured in that accident. Two of the recommendations made by the Government Inspector of Railways in his Report on that accident were:—

> "(i) Bridge No. 393 at Mile 174/4-5 should be located at a better site and adequate waterway should be provided.
>
> (ii) The stability of all bridges should be investigated in the light of the maximum possible flood and action where wanting should be taken."

The bridge was re-sited and a new girder bridge consisting of eight 40 feet spans was built in place of the old waterway which comprised of only four 20 feet spans. The Government Inspector of Railways in Annexure I to his Report on the Jangaon Accident also recommended that—

> "a list of all danger points should be made out, a predetermined limit of safety in each case should be clearly laid down, full-time watchmen at all such points should be posted during the monsoon and detailed instructions as to the

action the watchmen should take when danger is apprehended should be specified."

Directives issued by Railway Board in December 1954

In December 1954, certain instructions were issued which *inter alia* suggested action to be taken on the lines indicated in a circular letter, dated 2nd December, 1954, sent by the Railway Board to the General Managers of all Railways. After drawing the attention of the General Managers to the necessity of meticulous observation of all relevant rules and regulations in the Indian Railway Way & Works Manual, the Board proceeded to state:

> "The Deputy Chief Engineers or Regional Engineers, as the case may be must carefully examine the Inspection Reports for the last 15 to 20 years of all the bridges in their jurisdiction and specially select those that have a past 'history'. This may consist of wash-aways, settlement, or tilting of piers and abutments, abnormal high flood levels, heavy afflux, deep scour near piers and abutments or in their vicinity, any breaching of approaches, diversion of channels from one bridge to another and so on. In this respect, no distinction should be made between Major and Minor bridges or so-called important and unimportant bridges, as a major accident can be caused by the sudden washing away of even a small culvert.
>
> The Deputy Chief Engineers or the Regional Engineers should then personally inspect all bridges having a past history as well as others considered necessary and satisfy themselves that the bridges are in safe condition and likely to remain so under flood conditions. Results of their inspection should be recorded in the Bridge Inspection Registers. Bridges on open foundation may require special examination with regard to depth of foundations and adequacy of water-way in the case of those recording abnormal high flood levels and heavy afflux".

The Railway Board also directed that written instructions should be issued by the Deputy Chief Engineers or Regional Engineers, if necessary, in consultation with the Chief Engineers, *inter alia* for:

> "Action to be taken in case of emergency arising out of heavy rainfall, high floods, deep scour, threatened breaches of approaches, and other circumstances that may endanger the safety of the bridges or the formation, to ensure public safety in all circumstances."

The Railway Board also made it clear in that letter that these instructions were to be strictly followed by all concerned and that the lines of action suggested in the letter were by no means exhaustive and all action that may be initiated should be finalised before the onset of the monsoon of 1955. A copy of this letter of the Railway Board is annexed to the Report of the Government Inspector of Railways as Appendix I-C.

Circulars issued by Chief Engineer

In pursuance of the instructions and directives given by the Railway Board in the letter of 2nd December 1954 and in amplification of certain directions already given by the Chief Engineer in November 1954, some circulars were issued, directing certain precautionary measures to be taken at the executive level. I shall refer to the same later on in the Report. Action was initiated for checking of waterway of all bridges with past history and a decision was taken to extend waterways of 12 bridges on this Sector. It does appear, however, that no inquiry was directed into the question of discharge of water through a large number of other bridges on the old Nizam's State Railway which are in hilly terrains.

Patrolling of the section and watch at night

A mobile patrolling system at night on the Jadcherla-Mahbubnagar section was introduced in the monsoon of 1956 to a specified time-table. This section of 11 miles was divided into 4 batches, each 2¾ miles in length and watched by patrolmen. The duties of patrolmen, provided with necessary equipment, were to look out for damage to track such as subsidence, erosion and other causes likely to endanger the safety of the line and stop traffic when any mileage was likely to be rendered unsafe or rendered unsafe due to flood or any other cause.

In addition, day and night watchmen were posted at bridges considered vulnerable to the effect of monsoon on the basis of their past history and also at bridges in whose catchment areas railway affecting tanks exist. Watch during the monsoon of 1956 was also directed to be kept on bridge which had been re-built or extended in the year 1956. A further direction related to grouping of bridges lying within a distance of one mile which could be watched by a single watchman. On the Jadcherla-Mahbubnagar section, watch was kept over five groups of vulnerable bridges, one such group being bridge 229 at Mile 66/15-16 and bridge 233 at Mile 67/9-10. One watchman with complete protection equipment was posted on this beat by day and by night. The movement of bridge watchmen over their beats was not governed by any time-table but the directive was that they should be constantly vigilant.

Evidence

The Government Inspector of Railways has examined 82 witnesses and made his Report. The whole evidence recorded by him is taken as part of these Proceedings since I have been asked to consider his Report and take only such additional evidence as may be necessary. As I have already pointed out, of these 82 witnesses, 18 were examined before me as I felt it necessary to record some additional evidence. Evidence of two other witnesses—the Chief Engineer, P.W.D. and Additional Chief Engineer, Irrigation, P.W.D., Government of Andhra Pradesh, was also recorded by me. I shall, of course, take into consideration the entire evidence but in my summation of it I do not intend to deal with each one of the multitude of witnesses who had to be examined by the Government Inspector of Railways and shall confine myself to what the important witnesses have stated

before the Government Inspector of Railways and at the Inquiry before me.

Shri Mohammad Yousuf, driver of the Passenger Train, had given evidence before the Government Inspector of Railways. He was also examined before me. It was a dark night, and it was raining moderately at the time of the accident. His speedometer was not registering but his estimate of the speed of the train was between 20 and 25 M.P.M. He did not hear any sound of rushing water. When the engine went down, he felt as if he was going down and coming up. Water rushed into his cab and rose up to his neck. He did not notice any danger signal exhibited by the night watchman looking after the bridge. The headlight of his engine was properly burning and properly focussed. There is other evidence to show that there was trouble about the headlight of the engine and the headlight was not burning at the time of the accident. At first sight this may appear to have bearing on some of the questions that arise for determination but it is not possible to take this factor into account because even if the headlight was burning there was not the slightest chance of the train being pulled up before it went down the bridge. The railway line comes round a curve just before bridge 229 and I have satisfied myself that it is not possible to see the bridge until the train comes very close to the bridge.

Shri Narasimha, the 1st fireman of the engine, was also examined before me. The speed of the train just before the accident was about 30 miles an hour. He had received injuries on his right eye-brow and head. He had slight abrasions on his forearms and there was bleeding. Shri Satiah, the 2nd Fireman of the engine, was also examined before me. He said that the time of the accident it was very dark and the rainfall was slight.

Shri Prakash Rao, the guard of the Passenger Train, was also examined before me. When the accident occurred he received a heavy jerk and fell down. He noticed the lights going out and the time to be 00.20 hours. He lighted the hand signal lamp and managed to re-light the train. He sent an urgent memo through the gateman who met him. Along with others he rendered first aid to injured persons. He estimated the speed of the train to be about 30 M.P.H. Before me he stated that there was some water on the cess when he went near the third bogie. The water might be flood water. It seemed to him that water had over topped the track and flowed to the left side where he was walking. That was about 4 or 5 minutes after the accident. It was very dark and raining at the time of the accident. He could hear the noise of flowing water.

Shri M. M. Baig, travelling ticket examiner on the train, gave evidence before me. He was in the fourth coach that was standing on the rails. He noticed that water was flowing over the abutment of the bridge and touching the lower footboard of the third carriage the rear portion of which was on the rails. When he came near the third coach and was standing near the cess, his shoes were under water. He also noticed that water was flowing at that time over the cess.

Shri Jalal Sab, the gangmate, stated before me that he has been in charge of the gang in this area for 34 years. There was no previous breach at bridge 229 prior to the 1st August 1956. The strength of his gang is 14 men, of whom 4 were watchmen and 2 were patrolmen. In his beat of 4 miles and 2 telegraph posts, there were five vulnerable bridges Nos. 221, 222, 226, 229 and 233. They were divided into two groups, one comprising bridges 229 and 233. Before 1st August 1956 bridges 229 and 233 were looked after by one watchman by day and by another at night. Till the restriction of speed at bridge 229 after restoration of the breaches was removed there were extra men sanctioned at the bridge. When the restrictions were removed on 21st August 1956 the former system of having one watchman by day and another by night to look after bridges 229 and 233 was resumed. Shri Bheemadu was one of the watchmen who looked after these two bridges before 1st August 1956 and also thereafter. He worked alternatively by day and by night. The distance between the two bridges has now been ascertained to be 0.6 mile. The two patrolmen who are members of his gang worked only by night. The length of the patrol beat covering bridges 229 and 233 was $2\frac{3}{4}$ miles ($64\frac{1}{2}$ to $67\frac{1}{2}$ miles). His patrolmen and watchmen had to keep an eye on the height of the water flowing under the bridges. They were only concerned with the "red mark" by which he meant the pre-determined safe flood level. The pre-determined safe flood level at bridge 229, it may be stated, was fixed as 1 foot below the bottom of the girders. He stated that it was 2 yards higher than the "black mark" by which he meant the highest flood level (H.F.L.) recorded at this bridge. This it may be mentioned was 2 feet 11 inches above the bed level and was attained in 1937. As I shall point out later on the H.F.L. must have been considerably higher. After the wash away on 1st August 1956, his gang had attended to the work of restoration to the breaches at bridge 229 on 1, 2, 3, 4, 8, 9, 13, 20, 22, 24, 29 and 30th August 1956, that is in all for 12 days. On the first four days, the work done was of repairs. After that the work done related to packing and lifting of the approaches. He was questioned on this point before me and he stated that if necessary some work of packing or lifting might have been done once a week after 1st September 1956. It does appear from the records that the witness was in error when he stated that the work of actual lifting of the approaches continued till 29th and 30th August 1956. The muster sheets show that no lifting was done on these days. The only work done on those days was "picking up slacks". His instructions are that when there is heavy rainfall, he must proceed with his equipment and gangmen towards the site where danger is expected and take steps to protect the track. He gets weather warnings from the permanent way inspector either personally or through a watchman or any other gangman. He had received a weather warning on 31st August 1956. He had always found the watchmen at their posts.

Shri Kistadu and Shri Adivigadu Balliah, two of the patrolmen, were among the witnesses examined before the Government Inspector of Railways. Shri Kistadu in his statement before the Government Inspector of Railways had stated that the headlight of the engine when he saw the train passing soon before the accident was burning but not brightly. On further questioning he had stated that the headlight was not burning but what he meant was that the cab lights were burning.

Shri Adivigadu Balliah was examined before me. His beat on the night of 1st September 1956 was from 64/14 to 67/8 miles. He was at Mile 67/8 at about 22.30 hours. After about half an hour he observed thunder and clouds in the direction of the hills. Anticipating heavy rush of water between 68/7 and 68/10 miles which part of the track is tank affected and with previous history he proceeded in that direction although his beat ended at 67/8 mile. When he reached Mile 68/4, he observed a red signal being exhibited by Bridge Watchman at Mile 68/9. He turned back towards Jadcherla exhibiting a red signal. When he came to Mile 67/11 he saw Bheemadu, the watchman posted to look after bridges 229 and 233, fixing detonators on the track. It appears that about 15 minutes after this Bheemadu, the night watchman, traced his beat in the direction of bridge 229. Balliah, the patrolman, also went in the same direction. When asked why he went beyond his beat, Balliah stated that he considered it advisable to proceed towards Mahbubnagar to make sure that the portion at Mile 68/1-13 was properly watched. He found water overflowing the track and could not reach the watchman at Mile 68/9-10. He had noticed night watchman Bheemadu posted to watch bridges 229 and 233 on duty twice when he had earlier passed bridge 229. He had also seen Bheemadu when the latter was at Mile 67/11 fixing detonators. Before me he deposed that there was no rain between 5 and 10 P.M. on 1st September 1956. Heavy rains started at about 11 o'clock that night and by midnight the rain had stopped. It may be observed that the hours mentioned by him cannot be regarded as quite accurate.

Shri Bheemadu, the watchman on duty, on the night of 1st September at Bridges 229 and 233, is one of the principal witnesses in this Inquiry. Before his deposition at the Enquiry by the Government Inspector of Railways was read out to him, I asked him to state what happened that night. He took up duty at 6 o'clock in the afternoon that night. After waiting sometime at bridge 229, he went to bridge 233. Before he left he had noticed that the water level under bridge 229 was about 1½ feet. He waited at bridge 233 for some time and returned to bridge 229. When he was at bridge 229, he noticed the water level under that bridge to be 3 feet. In the Report of the Government Inspector of Railways this figure is shown as 4½ feet. That is obviously a mistake. He was unable to say anything about the time even approximately. He only went by the movement of stars on clear nights. When he was at bridge 229, a goods train passed the bridge. This was about 21.00 hours, as appears from the evidence of the driver of the goods train. Bheemadu must have been at bridge 229 for some considerable time. After waiting at bridge 229 he went for the second time to bridge 233. When he reached bridge 233, he observed that patrolman exhibiting danger signal. He, therefore, placed detonators on the track at Mile 67/10-11. After placing detonators he waited for about 15 to 20 minutes till the patrolman returned and told him that the track on the other side had been washed away. He, thereupon, proceeded towards bridge 229. While he was at a distance of about 4 telegraph posts (about 1200 feet from bridge 229 he heard a loud noise and saw the train crash under the bridge. He went up to the engine and found that it was impossible for him to cross over to the other side of the bridge. He went towards the P.W.D. Road and contacted the gangmate at the gang quarters which

are at Mile 65. When asked to state if any special instructions were given to him after 1st August 1956 he stated that he had been instructed to stop trains if the water level exceeded the red mark (predetermined flood level). He had been instructed to keep a look out for any loose material because the approaches to the bridge had been repaired. He had also been told that if at any place the track showed any sign of sinkage he should stop trains. These instructions had been given to him by the permanent way inspector. After the accident he was in a state of confusion. When asked if he had at any time seen the permanent way inspector on the line at night he stated that the permanent way inspector used to go on the line by trolley once a week at night.

Shri Srihari Rao, Chairman, National Railway Mazdoor Union, had given evidence before the Government Inspector of Railways. In that evidence he had stated that he was at Mahbubnagar station on the night of 31st August 1956 in the early hours of 1st September 1956. The Dronachellam-Secunderabad train was about to leave Mahbubnagar station at a little after 2 A.M. There was heavy down pour but the Station Master did not give any caution ticket to the driver of the train. He thought the train would go at a great speed and therefore got into a third class compartment, pulled the alarm chain and stopped the train. On being questioned at the station, he stated that it was not safe for the train to leave the station in a heavy downpour. The guard was not prepared to listen to him. Thereafter a complaint was lodged against him for pulling the alarm chain. It appears the prosecution is still pending. He stated that he had anticipated danger at the Pochani Nalla Bridge because his father had worked there for many years as a gang muccadum and he had himself worked as a waterman in the gang. Moreover, there was a breach at the Pochani Nalla Bridge 30 days ago and the railway authorities in his opinion had criminally failed to widen the bridge. This, according to him induced him to pull the alarm chain.

He was examined before me as a witness. When asked by me if he wanted to add anything to or modify or qualify anything already stated by him, his answer was that he wanted to do so. He stated that the watchman Bheemadu was not on duty on the night of 1st September 1956 as suggested by the railway authorities, but was sleeping at his place which is about 3 furlongs from the Pochani Nalla Bridge. When asked by me if he had any personal knowledge of the fact, he stated that he had no personal knowledge but added that he had made enquiries and verified the truth of what he was saying. He had no personal knowledge of anything that had happened on the night of 1st September 1956. I requested him to ask the persons of whom he had made enquiries to come and give evidence before me. At a later stage in the Proceedings, Shri Sivaram Sastry, an Advocate practising in the Andhra High Court, stated that he had been asked by the National Railway Mazdoor Union to appear at the hearing of the Inquiry. Shri Sastry was informed by me that he could appear for the Union. Learned Advocate also stated that he would enquire if evidence of any witnesses to contradict the evidence of Bheemadu was in fact available and if available he would examine such witnesses before me. The next day, Shri Sivaram Sastry stated that he had no such evidence and the Union did not want to be represented before the Commission.

Shri Seshachalam, the permanent way inspector, stated in his evidence that he had instructions to put on night patrol and day and night watchmen during monsoon at bridges with previous history and tank-affected bridges. All the bridges had marks showing "pre-determined level". This was done in accordance with the instructions of the Chief Engineer. He instructed the watchmen, patrolmen and other staff to take action according to Chief Engineer's circulars. He received weather warning telegrams when heavy rains were expected and on receipt of the same he used to instruct his gangmen to be particularly vigilant. He stated that he himself also went out to inspect vulnerable bridges. He said he received a weather warning telegram and had gone out to inspect the bridge at Mile 71/4-5 between 01.00 and 03.00 hours on 1st September 1956. On 1st August 1956 he had trollied over bridge 229 at about 13.00 hours *i.e.* about 45 minutes before the approaches of the bridge were washed away. On coming to know of the wash away he had returned to the bridge. The damage to the approaches had occurred due to a breach in the bund of the Pochani Tank. There was no previous history of bridge 229 except for the breaches to the approaches of the bridge in consequence of the bursting of the bund. There was no record to show that water had ever risen above the highest flood level noted at the bridge. He described the work of restoration that was carried out after the breaches on 1st August 1956. The breached approaches were built up of moorum, coal ash and boulders and the top-most portion was laid on sleeper cribs at a height of 2½ feet on the Secunderabad end and 3½ feet on the Dronachellam end. The traffic was resumed after 25 hours of the damage when a YG engine with ballast rake crossed the bridge. Subsequently, other traffic was resumed at 'Stop Dead and 5 Miles per Hour'. The restriction was relaxed to 10 Miles per Hour Non-Stop on 9th August 1956. On 13th August 1956, the speed of 20 Miles per Hour was allowed. The restriction was removed and usual speed was resumed on 21st August 1956. Between 1st August 1956 and 1st September 1956, he had inspected the place by various means on 17 occasions. On the 30th August, he had gone over the bridge on a trolly. The track had been checked by Hallade Track Recorder on the 6th and 16th August 1956 and no defect had been noticed. He had checked the work of night patrolling and night watchmen and had not found any cause for questioning their vigilance. He stated that on 3 occasions during monsoon of 1956 his gangmen had stopped traffic in this section. On the 1st August 1956 the same night watchman Bheemadu had stopped traffic after the approaches to the bridge had been washed away in consequence of the breach at the Pochani Tank. On the night of 1st/2nd September 1956, when he came to know of the accident, he immediately went to the site. In his evidence before me, he stated that the high level reached by flood water on the night of 1st September 1956 must have been a matter of less than an hour. He denied that there was any settlement in the restoration works after the same were completed.

Shri Padma Rao, the Assistant Engineer of the Secunderabad, Dronachellam Sub-Division, stated that he had attended to the work of restoration of the breaches at bridge 229 on 1st August 1956. His description of that work is the same as that given by Shri Seshachalam, the permanent way inspector. Night patrol was ordered from 1st June 1956. Besides monsoon patrol, at bridges with past history,

watchmen were posted. At tank-affected bridges described as vulnerable, watchmen were posted when the tanks got full. He was asked about the Bridge Inspection Registers. He stated that such Registers were available for the years 1937 to 1955. He did not know what had happened to the Bridge Registers prior to 1937. He stated that there was no past history of any damage done to bridge 229 previous to 1st August 1956. After the breaches on 1st August, he had inspected the Jadcherla-Mahbubnagar section seven times, once by trolly and six times by train. When asked about the supervision exercised by watchmen and night patrolmen, he stated that while passing by night trains he looked out to satisfy himself that night patrolling was done properly and bridge watchmen were on the job. He also used to enquire from the Permanent Way Inspector about work done by these watchmen and patrolmen and also from the Station Masters whether the patrolmen were arriving and departing to the specified time-table. In his evidence before me, he stated that the length of his section is 184 miles and he used to trolly about 25 miles a day. He also attended to building works, repair works and inspection of yards. He had orders to appoint patrolmen and watchmen during monsoon and he had been supplied with copies of all Circulars issued by the Chief Engineer. He stated that he used to give instructions to those subordinate to him in accordance with the Circulars. He had posted special watchmen for bridges 229 and 233 in accordance with those instructions. When asked whether it was not necessary for him to ask the Divisional Engineer to sanction a special watchman exclusively for bridge 229 he answered that it had not occurred to him. The sanctioning authority is the Divisional Engineer and the Divisional Engineer was on the site. He had not personally inspected the Jadcherla-Mahbubnagar section between the 15th and 23rd August 1956. The speed restriction was removed by the permanent way inspector after consulting him. The permanent way inspector had tested the line before the 23rd August 1956. He had received instructions from the Divisional Engineer to remove the restriction in course of time.

Shri Yasin Ali Khan, the Divisional Engineer, has been in charge of the Western District of the Secunderabad Division since November 1953. In his evidence before the Government Inspector of Railways he pointed out that bridge 229 had no past history since its construction 40 years ago except that on 1st August 1956 its approaches were washed away as a result of a breach in the bund of the Pochani Tank. A detailed account of the damage and restoration work done under his personal supervision was sent on by him in a report to the Divisional Superintendent, Secunderabad, who had forwarded the same to the Chief Engineer. When asked to describe the procedure followed for watching vulnerable bridges he stated that this was done in accordance with the directions given by the Chief Engineer in his revised Circular No. 46, dated 10th May 1955. The beat of watchmen for vulnerable bridges was up to one mile or less. One watchman was posted by day and one by night. It was the duty of the watchman to move up and down the beat keeping a watch over the bridges. The limit of one mile was fixed by the Chief Engineer when he modified by his letter of 10th May 1955 instructions given in an earlier letter dated 13th November 1954. At no time more than one watchman had been provided for bridges 229 and 233. He had information from the watchman that on 1st August 1956 water had risen to the rail level.

within an hour. When asked whether in view of that fact he considered that there would be sufficient time for the watchman to go from bridge 229 to the other bridge, examine the same and come back and be in position to protect an approaching train, his answer was that the bridge had no previous history and as the cause of the breaches on 1st August 1956 had been definitely established *viz.* the bursting of the tank, the bridge no longer remained vulnerable and there was no question of anticipating any sudden rise of flood water as had happened on 1st August 1956. The distance between the two bridges was less than $\frac{2}{3}$rd mile and the watchman could easily go from one bridge to another and be in time to protect a train approaching from any side. On being further questioned as to why he had continued the night watchman for bridge 229 when the bridge according to him ceased to be vulnerable he said that the approaches to the bridge had been newly restored and the watchman was expected to guard the newly built-up approaches in accordance with the instructions given by the Chief Engineer in his letter of 6th July 1956. It will be necessary to refer to that letter later on in my Report. He also stated that bridge 229 had been minutely examined by him after 1st August. He found that the masonry work, foundation, bed blocks, flooring and girders of the bridge were stable and in a good condition except that the coping stones of wing walls and pedestals of the upstream side had been washed away and the ballast walls slightly damaged. The coping stones were restored and the bank behind the abutments was made up. Pitching was provided behind returns of the upstreams side of the Secunderabad end and downstream side at the Dronachellam end upto about 4 feet. His description of the repairs done to the approaches after the breaches of 1st August 1956 was on the same lines as that given by the permanent way inspector and the Assistant Engineer. Bridge 229 was built in 1916 as appears from the completion drawing but no calculations were available to show on what basis the waterway was provided. No calculations were available in the Divisional Engineer's office. They are according to the witness supposed to be in the Chief Engineer's office. It may be observed that no records of any calculations showing the basis on which the bridge was built were produced in evidence. I am satisfied that they must not be available. He agreed that the velocity of 10 feet per second would be reasonable on a steep gradient and for low flood level. The total run-off according to him would be approximately 2,250 cusecs, if Dickens' formula is adopted. He also stated that if velocity of 10 feet per second was taken, 570 cusecs of flood water going under the bridge would reach a flood level of 2 feet 11 inches. When asked if he considered the highest flood level of 2 feet 11 inches recorded at the bridge to be correct, he stated that there was no evidence to show that the noted level of 2 feet 11 inches had been exceeded except on 1st August 1956. He also stated it was difficult to say whether the recorded highest flood level was correct or not. In passing it may be observed that the level of 2 feet 11 inches would be reached even if the rainfall in the catchment area was about $\frac{1}{4}$ inch in an hour taking 70 per cent. run off. When asked about the Project Report, he stated that it did not give any formula but his surmise from flood discharge noted for certain important bridges was that Dickens' formula was used with a constant of about 800. He inspected the bridge on 2nd August 1956. He tested the running quality of the track over the approaches of the bridge when he went on his next inspection by an express train on that day. . The result of his

test was that the running quality of the track over the approaches of the bridge was excellent. He had satisfied himself that the night watchman Bheemadu was on duty on 1st/2nd September 1956.

In his evidence before me, Shri Yasin Ali Khan stated that he gave top priority to track maintenance and less priority to Works and his other duties. He said that he had received various circulars from the Chief Engineer regarding Inspection of Bridges, Protective Works, Damage by Floods and other matters. He agreed that he was responsible for carrying out those instructions and for seeing that his subordinates did likewise. It was put to him by Shri Mitra that the circular letter of the Chief Engineer dated 6th July 1956 required an exclusive watchman to be kept both by day and by night and that a very close watch should be kept. On being asked by Shri Mitra what he had to say about the same, his answer was that the Chief Engineer had in that letter stated that a close watch should be kept for bridges where the approach fills are made up. His reading of those instructions was that the Chief Engineer had desired to emphasise and reiterate the need for a close watch on newly made up approaches. The expression "Watchmen by day and by night" in the circular did not mean that exclusive watchmen need be kept at the places. Watchmen wherever posted whether by day or by night, whether for one bridge or for a group of bridges, the instruction for "close watch" was similar to the instructions of the Chief Engineer regarding watch on bridges affected by tanks in their catchment areas, or those with "past history". In the context of all the orders received by him from the circulars of the Chief Engineer and the circumstances relating to bridges 229 and 233, he considered that adequate watch could be kept by keeping one watchman for both the bridges as they were at a distance of ⅓rd mile from each other. That, according to him, was the intention of the Chief Engineer and had been confirmed by him in a discussion on 2nd September 1956 which he had with the Chief Engineer after the accident. After the damage to the approaches of bridge 229 on 1st August 1956 the bridge remained no longer "tank-affected". It did not have any past history. It was as safe a bridge as any other not having any past history, except for the fact that due to restoration of its approaches there was a possibility of sinkage for which a watch was considered necessary.

The Divisional Engineer went on to state that he used to give all directions in regard to employment and posting of watchmen. He did not consider it necessary to post a stationary watchman at bridge 229 after the restoration of the approaches because the restoration work had been carried out under his personal supervision and his experience was that there would be no sudden sinkage which could cause immediate danger. The sinkage could be very small and could be readily detected. When asked to describe the nature of work carried out after the breach on 1st August 1956, he produced a sketch showing the nature of the work that was done. The usual and normal method of restoration was followed by him and that was accepted by higher authorities and no objection was at any time taken by them to the method adopted in this case. When asked about the settlement in case of repair work of the nature described by him and done after the breaches of 1st August 1956, he stated that when he passed the heaviest type of engine, the YG, over the restored portion, there was hardly any sinkage. That satisfactory condition according to him

was not only due to the cribs but also due to interlacing of steel trough with wooden sleepers. He relied on the muster sheet of the gang to show that the gang did not have much to do in regard to lifting of track but was engaged throughout on 'picking up slacks'. No 'through packing' was required to be done. That according to him established that the method adopted for restoring the embankment minimised the effect of sinkage of track. The relevant muster sheet relied on by him was scrutinised. It was put to him that the gangmate has stated in his evidence that lifting was done as late as 29th and 30th August 1956. He explained that the gangmate had obviously made a mistake. The muster sheet showed that no lifting was done on those days. The only work done on those days was 'picking up slacks'. The possibility of any sudden settlement after restoration of normal speed was remote. The possibility was about ½ inch in five days. Between 21st and 31st August 1956 about 5 inches of rain had fallen and on one day the rainfall was about 2 inches. In spite of that there was no sinkage between 21st and 31st August 1956.

When asked if he had applied his mind at any time before 1st September 1956 to the question of discharge of water under bridge 229, the Divisional Engineer's answer was in the affirmative. He stated that the tank was in disuse until 1953 when water was impounded after restoring the bund. For all purposes the *status quo* existing before 1953 was restored after the breach at the tank bund on 1st August 1956. Before 1953, there was no moderating influence of the tank on the discharge of water from the area covered by the tank. Having known the configuration and the circumstance of bridge 229 there was in his opinion no cause for any anxiety to go into further details. On being questioned about consolidation after the repairs in August, he stated that before the last week of August there was enough rain which had been percolating through in the banks. He asserted that the banks were fairly consolidated, during the month of August, and it was his experience that consolidation did take place in three to four weeks' time and such consolidation would be sufficient to permit normal speed of trains. Chances of percolation even if the flood level had risen to 12 feet, were considerably reduced by 21st August 1956 when the speed restriction was removed. He stated that it was because there was a possibility of the new banks slightly eroding that a watch was kept on the bridge.

He also stated that with a flood discharge of 3,400 cusecs through bridge 229, the flood level will over-top the railway line. He agreed that if 3,500 or 4,000 cusecs of water were to be discharged the approaches would be seriously affected because the normal capacity of free flow through the bridge would be exceeded. He also agreed with Dr. Rao that the bridge was not safe for a rainfall of 2 inches in one hour in the catchment area. He said he was quite sure of that. He had not considered it necesary to make any technical examination of the hydraulic data after the breaches of 1st August 1956 in view of the fact that the tank had been in disuse for several decades before 1953 and the position after the bursting of the tank was the same as had obtained in all the years prior to 1953. When asked whether he was sure that the repaired formation after 1st August 1956 would sufficiently stand the discharge of 2,250 cusecs he stated there was no question of being sure for the earlier stages of consolidation and that

was why there was speed restriction. On being asked if it was necessary for him to be more cautious in view of the Jangaon accident he replied that caution would have been necessary if there was the slightest apprehension of danger to the bridge from normal monsoon flood. He added that if caution had to be observed for abnormal rainfall then practically every bridge on the railway line would have to be treated as "threatened". According to him rainfall of 2½ inches in one hour in the catchment area was something unprecedented and abnormal. In answer to me, he stated once again that the ventway of the bridge was certainly inadequate to resist the flow of water resulting from 2 inches of rainfall in one hour in the catchment area. He also stated that to his knowledge no railway authority had at any time thought about the possibility of 2 inches of rainfall in an hour in the catchment area of Pochani Nalla.

Shri F. X. Lobo, Deputy Chief Engineer, has at all material time been in charge of the South Zone of the Central Railway. In his evidence before the Government Inspector of Railways, he pointed out the various precautions that had been taken in recent years for protection of trains. He referred, in his evidence, to his circular letter dated 17th December 1954. He drew attention of the Divisional Engineers to the Railway Board's letter of 2nd December 1954. It is clear from his letter that the investigation of bridges that was directed was in respect of bridges having past history and this examination was to be done by checking up Bridge Registers covering a period of 20 years. In another para. of the same letter he referred to Railway affecting tanks and canals, and directed that action should be progressed immediately if any necessity arises for strengthening, widening or rebuilding of bridges or for re-siting of bridges which were tank-affected. Unfortunately, bridges other than those with past history and those which were not tank-affected were not taken into consideration at all and no investigation or examination in respect of them was directed.

After the accident of 1st/2nd September 1956, he had inspected the unaffected portion of the masonry of the bridge. In his considered opinion, the masonry was in excellent condition. On his attention being drawn to the High Flood Level at the bridge being recorded as only 2 feet 11 inches above the bed level and on his being asked whether he considered that to be correct in view of the rainfall in that area and the nature of the catchment, his answer was that the High Flood Level was recorded in the Bridge Register in 1938 and that he had no reason to doubt the authenticity of that record. He had, however, felt that it was possible that the level mentioned in that Bridge Register could have been exceeded without being noticed by patrolmen at night time as watchmen had not been appointed till 1955. One of the questions put to him by the Government Inspector of Railways was—

> "Was the extent of catchment, amount of run-off or the velocity that may be obtained by the flow when flowing up to a predetermined level, considered and the safety of the bridge in that light examined?"

His answer was—

> "No check of this nature was done nor is it possible to do so in the case of each and every bridge. This bridge had no past

history and only after it came to be known it was tank-affected, that the pre-determined level in accordance with a rational basis was marked."

In his evidence before me, he stated that whenever he went on tour, he made it a point to ask all the officials from the Divisional Engineer downwards whether they understood the instructions given by the Chief Engineer and whether they were carrying out the same. He used to discuss the instructions with the subordinate officials and satisfy himself that they understood the instructions and were carrying out the same. On being asked whether he had applied his mind to the question whether bridge 229 required any modification in its structure after 1st August 1956, he stated that the Divisional Engineer's Report of 3rd August 1956 stated that the bridge carried no past history and that the breaches on the approach banks had been caused by the bursting of the Pochani Tank. It was clear to him, therefore, that the abnormal flood was caused by the bursting of the tank and exceeded the capacity of the bridge. From that it could not be said that the bridge had acquired history and, therefore, it was not regarded by him as a bridge carrying past history as a result of monsoon floods. He went on to state that it had also been brought out that the High Flood Level did not exceed 2 feet 11 inches above the flood level since 1937 and that the Pochani Tank was lying in a state of disuse for many years prior to 1953 and the catchment was, therefore, a free catchment and that no abnormal flood had been registered at any time. The bridge had been designed for a run-off from the free catchment area and the necessity for examination of the waterway, therefore, did not arise. But after the accident of 1st September 1956, the hydraulic particulars had been ascertained. He added that in his jurisdiction of about 2,150 miles there are 176 bridges that carry past history and 323 tank-affected bridges all of which were watched during the monsoon. It was only in respect of bridges carrying past history that action had been initiated in checking up hydraulic data and that in the case of tank-affected bridges watch was arranged. He was specifically asked if he did not think that history was created on bridge 229 on 1st August 1956. In reply, he stated that by history he meant only monsoon-floods causing damage to bridges. What happened on 1st August 1956 was a case of bursting of the tank and so bridge 229 was not catered for.

On being questioned about the method in which repairs to breaches were carried out, he stated that it was a well established procedure to use coal ash for restoring railway embankments. In the monsoon of 1956, when a serious breach had occurred between Bombay and Poona the same method was employed at Battery Hill which was exposed to about 200 inches of rain per annum. He would have himself followed the same procedure of restoration that was followed by the Divisional Engineer. On being asked whether he was satisfied that the embankments of bridge 229, after restoration, were so stabilised as to warrant the removal of speed restriction after three weeks, he said that as the packing was done regularly and that there was no settlement known, there would ordinarily be no objection to removing the speed restriction. In answer to a further question, he stated that when it rained very heavily, he might expect some settlement but the gang could pay special attention to that portion of the track as and when

required. There should be no settlement after the removal of speed restriction. The bank in the process of being made up becomes partially consolidated with workmen walking over it with headloads of materials and ballast trains passing over it at low speed and any settlement observed would immediately made up and the track packed again. That process continued several times and by moving the Material Train up and down, the settlement was negligible and the traffic was restored at slow speed. On being asked about the use of stones in restoration of the embankments, he stated that there was no set idea in using stones. Material Trains loaded with boulders and coal-ash are rushed to the scene of washaway on receipt of information. The time is the important factor and all available materials such as coal-ash and soil available locally are dumped in the breached area and the boulders used are generaly small in quantity. He added that the procedure adopted in restoration of embankments had stood the test of time.

In answer to questions put by me, he pointed out the considerations on which it was decided to group bridges. When lists of bridges that were required to be watched were received from the Divisional Engineers, it became known that there were a number of bridges required to be watched during the monsoon and that they were situated close to each other. It was thought that these bridges could be grouped over short beats and watched effectively. According to him, with this arrangement and monsoon patrolling system in vogue, these short beats received intensive patrolling and watching. The workability and practicability of this arrangement was given due thought and consideration and it was then decided to group such bridges within a distance of one mile. It will be necessary for me at a later stage to consider the wording of the instructions relating to grouping of bridges issued by the Chief Engineer in his circular letter dated 10th May 1956 and the practice relating to grouping of bridges that was in fact followed by the Divisional Engineer under instructions from the Chief Engineer and the Deputy Chief Engineer. Shri Lobo went on to state that the bridge watchmen by day and by night are required to be vigilant during duty hours. He did not mean to suggest that they must walk up and down all the 12 hours but they must walk up and down as frequently as possible and be extra vigilant when it rains heavily or when the level of water in the waterways of bridges rises. They will be required to be extra vigilant on receipt of weather warning.

When asked:—

> "Will you agree that the period of duty of night watchmen being 12 hours even on a rainy night, there will always be the probability of his not being able to keep a close watch on one bridge for a period of about 2 hours due to his absence from that bridge?"

His answer was:—

> "The probability is there."

When I next asked him:

> "Was this probability taken into serious consideration when you decided upon the grouping of the two bridges?"

He stated—

"I do not think that this was in my mind, but I would like to point out that there is no end to safety precautions that can be taken."

It will be convenient to set out here the answers given by him to some further questions put by me on this point of grouping of bridges.

"Q. : Do you agree that a close watch on a bridge would be required in the case of breached approaches which have been newly repaired and have not been fully consolidated, the period being the rainy season?

A. : Yes.

Q. : Do you call watch by a night watchman who has to look after two vulnerable bridges within a distance of one mile very close watch?

A. : I call this a very close watch. By close watch I do not mean continuous watch.

Q. : Is a continuous watch required for Nallas in hilly terrains with gradients of, say, 1 in 100 where there is always a possibility of flood water rising suddenly?

A. : Not necessarily.

Q. : You have referred in your evidence to 'intervening formation' (between the grouped bridges) susceptible to damage. Would not the patrolman be able to look after this?

A. : Yes.

Q. : Chief Engineer's circular of 10th May 1955 modified his previous circular letter of 30th November 1954. May I take it that before November 1954 there were no instructions for grouping of bridges?

A. : Yes. There were none."

In answer to another question, he stated that after the Jangaon disaster it was realised that bridges on the ex-Nizam's State Railway required to be considered from the hydrological point of view and also stated that a decision had been taken to enlarge the span of the bridge at Jangaon. He added that waterways in case of some other bridges also had in fact been extended. He was asked:

"Q. : After the Jangaon accident, did you not think it advisable to direct an immediate enquiry into the discharge of water through bridges in this hilly terrain where a large number of bridges exist?

A. : I have initiated action after checking up waterway of all bridges with past history and as a matter of fact the work of extending the waterways of 12 bridges has already been completed and sanctions have already been communicated in a few more cases.

Q. : Did you confine your enquiry only to bridges with past history?

A. : Yes. In the first instance, there were 169 bridges with past history to be checked on the Secunderabad Division."

Shri N. M. Thadani has at all material time been the Chief Engineer of the Central Railway. In his evidence before the Government Inspector of Railways, he described all the precautionary measures for the protection of bridges that had been taken under the directions. I have only made some reference to the same and it will be necessary for me to refer to the same at a later stage. He stated that bridge 229 had been kept under watch because it was tank-affected and not because of previous history. He did not consider that after the Pochani Tank had breached on 1st August, the bridge remained vulnerable. The bridge structure was sound but a watch was kept on the bridge because he had issued instructions in July 1956 that in the case of newly constructed bridges a watch should be kept during monsoon. I shall refer to the circular issued by him on 6th July 1956 later on in this Report.

Shri Thadani was asked by the Government Inspector of Railways:

> "Considering the speed with which the flood levels rise and fall in a hilly tract, do you consider it possible for a Bridge Watchman whose beat extends upto one mile to examine one bridge, proceed and examine other bridges in his beat and return to the Bridge originally examined and protect the train that may be approaching from that end?

His answer was:

> "He should be able to go round his beat in about an hour and that leaves sufficient margin to protect the train in hilly tracts".

In his evidence before me, his attention was drawn to the fact that Shri Bheemadu had to keep watch on that night on the two bridges 229 and 233 when heavy rain of great intensity was falling. He stated that in his opinion Bheemadu should not have waited at bridge 233. Knowing the fact that the approaches of the bridge had been washed away only a month previously, he should have gone back to bridge 229 to ascertain the condition of that bridge. His reason for the failure of the bank on 1st September 1956 was unusually heavy floods at Pochani Nalla on the night of 1st/2nd September 1956 which resulted in water overtopping the embankment. He was emphatic that there was appreciable overtopping of the bank by flood water on the night of the accident. When questioned by me about the propriety of grouping of bridges, he stated that grouping of bridges was not mandatory but was permissible when bridges require watch within a distance of one mile. He added that the Divisional Engineers were expected to take local conditions also into consideration when arranging for watches over groups of bridges. His suggestion obviously was that it was the Divisional Engineer who in his discretion had grouped bridges 229 and 233. In his evidence he persisted in justifying grouping of vulnerable bridges within a distance of one mile. He pointed out that on the very night of 1st September 1956 the embankment of bridges 237 and 238 at Mile 68/5-12 was breached and the damage was detected by the watchman detailed to watch that beat. He also stated that according to him, keeping of one night watchman for bridges 229 and 233 was not an error. When I asked him if he thought that in view of his recent experience, grouping of bridges for inspection

by night watchman should be dropped, his answer was in the negative. At the next sitting of the Commission, an application was made that he should be allowed to add something to the last answer given by him. He added:

> "The main factor in grouping of bridges in proximity to each other is the distance covering each such group and conditions at site. The question of intensifying watch on bridges taking all factors into consideration to ensure maximum possible safety is already under examination. I would like to add that even under the present system, exclusive watchmen have been posted on as many as 156 bridges on the ex-Nizam's State Railway."

In answer to a question put by me, he agreed that the ventway of bridge 229 would be unable to resist the flow of water resulting from 2 inches or more of rainfall in one hour in its catchment area. He also agreed that the examination of adequacy of waterways of bridges in hilly terrains such as existed on the ex-Nizam's State Railway should have been started after the Jangaon disaster of 1954, but he added that he had himself initiated investigation and had taken action to increase waterways on some bridges on the ex-Nizam's State Railway. The investigation directed as appears from the record was in respect only of all bridges with past history. The reason for this was that priority was given to bridges with past history. I may add that bridge 229 and other similar bridges which were regarded as carrying no past history remained uninvestigated.

Shri J. C. Hardikar, Additional Chief Engineer, Irrigation, Public Works Department, Government of Andhra Pradesh, Hyderabad, was requested to give evidence before me. A questionnaire had been sent to him and the witness read out his answers to the same. Copies of the questionnaire and Shri Hardikar's answers thereto are appended to his deposition before me. In answer to a question put by Dr. Rao, he stated that in his opinion bridge 229 was as important as culverts on the canal and that Dickens' formula with high coefficient should be more suitable. In answer to questions put by me, Shri Hardikar gave instances of high intensities of rainfall in Mahbubnagar between 1949 and 1954. On 23rd September 1949, the rainfall was 5·25 inches and on 28th September 1954, the rainfall at Mahbubnagar was 5·37 inches. The intensity of rainfall at Atmakur which is about 20 miles from Mahbubnagar was 9·5 inches on 23rd May 1952. It was not possible for him to state the intensity of rainfall per hour in the area around Mahbubnagar. It was suggested to him in cross-examination by the learned Counsel for the Railway that the intensity of rainfall mentioned by him in his evidence might have been due to certain sudden cloud bursts. The answer was it was difficult to say whether on those days there had or had not been any cloud bursts.

Shri L. Venkatakrishnan, Chief Engineer, Irrigation, Public Works Department, Government of Andhra Pradesh, Hyderabad, was also requested to give evidence before me. A questionnaire had been sent to him. His answers to the questions were read out by him. Copies of the questionnaire and his answers thereto are appended to his deposition before me. In answer to a question put by Shri Mitra,

he stated that the coefficient used for flood discharge varied with the nature of the catchment and that could largely be based on annual rainfall but it was not always so. On being questioned whether he would be prepared to allow a velocity of 12 feet per second on consolidated gravelly soil, his answer was an emphatic "No". On being further questioned whether he could be prepared to do so even occasionally, he stressed that he would not unless the flow of water was for very few minutes.

A questionnaire had also been sent to Shri M. S. Thirumale Iyengar, Chief Engineer, Hirakud Dam Project. His reply to the same was received in Bombay on the 8th January 1957, after the Inquiry at Hyderabad was concluded, and it was not possible to discuss the answers with the learned Assessors. The answers are confined to the design of cross drainage works in the Public Works Department. Copies of the questionnaire sent to Shri Iyengar and his answers thereto are annexed to the Proceedings.

Questions for determination

After this brief review of the evidence I now turn to the shape assumed by the Proceedings. The questions that fall for determination do not present any difficulty or complexity but some of the considerations that arise are of gravity. It will be convenient if those questions are succinctly stated. The questions formulated below include and cover all those that were suggested and discussed before the Commission by Shri Rajaram, learned counsel appearing on behalf of the Central Railway:

(1) What was the intensity of rainfall prior to the accident on the night of 1st/2nd September in the catchment area of the Pochani Nalla?

(2) Was there any defect in the restoration work of the approaches of bridge 229 after the wash away on 1st August 1956?

(3) Was it necessary for the Divisional Engineer to continue any speed restriction after 21st August 1956?

(4) Was the ventway of bridge 229 adequate to accommodate discharge of flood-water resulting from 2 to 2½ inches of rainfall in one hour or a little over one hour in its catchment area?

(5) Could bridge 229 have withstood the impact of flood-water if on 1st September the consolidation of the approaches had been as strong as it was prior to 1st August? Or to put the same question differently, could the bridge have withstood the impact of floodwater resulting from 2 to 2½ inches of rainfall in one hour or a little over one hour in its catchment area if there had been no tank in the catchment and no breach of the approaches on 1st August?

(6) Can it be said that the intensity of rainfall on the night of 1st/2nd September amounted to an act of God?

(7) Is this a case of inevitable accident?

(8) Was the watch kept on bridge 229 on the night of the accident adequate?

(9) Was it safe and prudent to group bridges 229 and 233 for being looked after by a single watchman?

Determination of these questions will lead conveniently to the ascertainment of the causes of the accident and the responsibility, if any, of any person or persons for the same, which are the main issues before the Commission.

Case for the Railway

I have not so far stated the case for the Railway for the reason that this is a statutory inquiry into the causes of the accident and the responsibility, if any, of any person or persons for the same. It is not confined to arbitrament of any specific disputes between two or more contestants. Even so, I think I should at this stage indicate briefly the submissions urged before the Commission by learned counsel appearing on behalf of the Railway. It was stated that there was no defect in the restoration work of the approaches of bridge 229 after the washaway on 1st August. It was also stated that there was evidence to show that on the night of 1st/2nd September there was unprecedented and heavy rainfall in the catchment area and there was sustained flow of rain water down the Nalla which had definitely overtopped the railway line by six inches to one foot. The submission was that considering all the relevant facts including hydrological data, a fair conclusion should be that there was nearly 3 inches of rainfall between 23.00 hours of the night of 1st September and 00.39 hours of the 2nd September. It was also stated that the intensity of rainfall was such that breaches to the approaches of the bridge would have occurred even if the embankments had not been repaired about a month before 1st September and had been in their old consolidated state. Learned counsel for the Railway argued that the rainfall was unprecedented and abnormal and that having regard to the same, the accident must be held to be an act of God. The bridge, it was stated, had been designed by an expert engineer but was not intended to accommodate a discharge of more than 2,400 cusecs which according to Dickens' formula that was used allowed for an intensity of rainfall of about 1·2 inches per hour with 70 per cent. run-off in the whole of the catchment area. It was also stated that even if the intensity of rainfall were to be assessed at about 2 inches in one hour that would mean that 4,000 to 4,500 cusecs of water rushed to the bridge and overtopped the railway line and caused serious breaches to the approaches of the bridge. All possible precautionary measures had been taken as would appear from the various circulars issued by the Chief Engineer and the Deputy Chief Engineer. These included intensive patrolling, posting of watchmen by day and by night and general supervision by the higher officers. Grouping of vulnerable bridges, it was stated, was no doubt done in case of bridges with "past history" and those which were tank-affected, but that was only for bridges lying within a short distance of one mile and in the present case, the distance between bridges 229 and 233 was only 0·6 mile. It was argued that neither the construction and maintenance of bridge 229 with a ventway to accommodate only 2,400 cusecs of flood water nor the grouping of bridges 229 and 233 could

be regarded as negligence or error. In view of the large number of bridges in the Secunderabad Division and the fact that there are 43 bridges between Jadcherla and Mahbubnagar within a distance of 11 miles, 13 of which carry either past history or are tank-affected, the grouping of bridges 229 and 233 cannot be said to be an error much less negligence. It was unfortunate that Shri Bheemadu was late by 15 minutes in reaching bridge 229. But for the fact that he saw a red signal on the Mahbubnagar side when he was at bridge 233 and waited there for about 15 or 20 minutes to meet the patrolman, the accident would not have occurred. After the Jangaon accident, the Chief Engineer had done all that was possible in the matter of investigation of bridges and 11 bridges had been extended or rebuilt. Investigation into or consideration of the catchment areas in the light of the maximum possible flood in respect of all bridges was not possible at the same time and action was initiated in respect of bridges with past history. All these circumstances and precautions, so it was suggested, showed that this was in any event a case of inevitable accident for which the Railway cannot be said to be responsible. I shall refer to the facts and circumstances relied on and the submissions made by learned counsel appearing on behalf of the Railway in some detail when I deal separately with the questions formulated above.

What was the intensity of rainfall

To take the first question first. The question of the intensity of rainfall in one hour or a little over one hour prior to the accident on the night of 1st/2nd September in the catchment area of the Pochani Nalla has been debated before me at some length. It is not possible to ascertain that intensity with the certitude afforded by a self-recording rain gauge. The nearest place of which metereological records could be obtained from the Director-General of Observatories, Poona, and the Director, Nizamia Observatory, Begampet, Hyderabad, is Mahbubnagar, which is at a distance of about 4 miles from Pochani Nalla. The rainfall recorded at the Mahbubnagar Observatory for the 24 hours ending 8.30 A.M. on 2nd September 1956 was 1·60 inches. The Government Inspector of Railways has stated in his Report (Page 38) that "the intensity of precipitation on 1st/2nd September 1956 may have been about 4 inches in one hour". He has referred to Cochran's formula for discharge from a small catchment. He was in error in asmuch as in his calculations based on that formula he took the catchment area as on 2·74 instead of 4·78 square miles. Accompanied by the Assessors, I have inspected the bridge and the Pochani Tank and we were pointed out both the right-side and left-side channels feeding the Tank. I have no doubt, and both the Assessors expressed the same opinion during the discussions I had with them, that the Government Inspector of Railways had erred in assuming that the cloud burst must have occurred only in the right-hand valley of the catchment. The inference of the Government Inspector of Railways about the possibility of the intensity being 4 inches in one hour cannot be accepted but even apart from his calculations on this point with which the Assessors, and particularly Dr. Rao, were not in agreement, the other evidence negatives the correctness of the intensity opined by him. Of the witnesses, Shri Yasin Ali Khan,

the Divisional Engineer, relied on this inference of the Government Inspector of Railways and stated that the intensity of rainfall in the Pochani Nalla had been ascertained by the Government Inspector of Railways to be 4 inches in one hour. His evidence on this point does not assist me in the least. The Government Inspector of Railways has also mentioned, in his Report, that the rainfall as recorded at Mahbubnagar Railway Station for the 24 hours ending 8.00 A.M. on 2nd September 1956 was 1·65 inches. Shri Sanjeeva Reddy, Cultivator, residing about half a mile from Pochani Tank stated in his evidence before the Government Inspector of Railways that there was unprecedented downpour between 22.00 hours and 24.00 hours. He noticed heavy thunder and lightning in the direction of Pochani Tank. Shri Enkaiah, an agriculturist, who resides in a village near the water-shed line of the catchment of Pochani Tank, stated in his evidence before the Government Inspector of Railways that there was unprecedented downpour accompanied by thunder and lightning between 22.00 and 24.00 hours. He had not seen such intensity of rain in his life. Shri Mohd. Husain, a retired Head-Constable, aged 84 years and a resident of another village near the water-shed line of the catchment of Pochani Tank, stated in his evidence before the Government Inspector of Railways that there was unprecedented rain between 22.00 hours and 24.00 hours. He had never seen such heavy rain. Shri Adivigadu Balliah, Patrolman, stated in his evidence before the Government Inspector of Railways, that while he was at Mile 67/8 at about 11.00 P.M. he had noticed tremendous gathering of clouds and there was thunder. He anticipated that there would be heavy rain. On being asked about the intensity of rain that fell that night when he was going towards Mile 68/4 from Mile 67/8 at about 23.00 hours, he said it was raining moderately and could know from the clouds and thunder that it was raining very heavily on the hills. In this state of evidence, greater reliance, in my opinion, should be placed on the rainfall recorded at the Mahbubnagar Observatory and the calculations about the intensity of rainfall based on the level of flood water reached at the railway bridge. I have already stated that the intensity of rainfall recorded at the Mahbubnagar Observatory for the 24 hours-ending 8.30 A.M. on 2nd September was 1·60 inches. Calculations based on the fact that there was overtopping of the railway line by about six inches to one foot show that 4,000 to 4,500 cusecs must have been the peak discharge which would have been the result of approximately 2 inches of rainfall in one hour in the catchment area. I should take into account the possibility of more than 1·60 inches of rain having fallen in the catchment area of the bridge which is about 4 miles from Mahbubnagar. But at the same time I cannot overlook the fact that weather warning was issued and it cannot be said that there was only localised rain in the catchment area. There was heavy rain that night in Mahbubnagar and its surroundings. I am also prepared to assume that almost all the rain on that day must have fallen after 11.00 hours of the night of 1st September and before 00.39 hours of the 2nd September. But making all assumptions in favour of high intensity of rainfall in one hour or a little over one hour soon before the accident it is difficult to see how I can reach any conclusion other than that 2 to 2½ inches of rain must have fallen in the catchment area. Dr. Rao in his written opinion, which he gave at my request, states that there was

concentrated rainfall in the catchment area of intensity of 2 inches per hour or over. Shri Mitra also appears to be of the same opinion. The conclusion reached by me that the intensity of rainfall in one hour or a little over one hour before the accident was 2 to 2½ inches does not differ from the submissin made by learned counsel appearing on behalf of the Railway, who suggested that, considering all facts, about 3 inches of rain must have fallen during the relevant period. That submission was principally based on the water level reached at the P.W.D. Road which is about 1,700 feet downstream. The high level of the flood water reached at that bridge cannot, in the opinion of Dr. Rao, be as good an index of the intensity of rainfall under consideration as the high flood level reached at the Railway bridge. I may, even so, add that calculations based on the high flood level reached at the P.W.D. Road bridge on the 1st/2nd September work out to about 2·9 inches of rain in the catchment area in one hour. I have reached the conclusion that the intensity of rainfall in the whole of the catchment area of the bridge was of the order of 2 to 2½ inches in one hour. I am supported in this conclusion by the opinion of both the learned Assessors.

Was there any defect in the restoration work after breaches on 1st August 1956?

The structural condition of the bridge and the soundness or otherwise of its approaches were obvious points which demanded careful and detailed consideration, and more so in view of the fact that the approaches had been washed away only a month before the accident and were newly restored. In my summation of the evidence, I have already referred in some detail to the restoration work that was done under the personal supervision of the Divisional Engineer. The Gangmate, the Permanent Way Inspector, the Assistant Engineer and the Divisional Engineer have all deposed to the nature of the work that was done immediately after the wash-away on the 1st August and some searching questions were put to these witnesses by the learned Assessors. The substance of their evidence on this point has already been given by me and need not be repeated. But I may very briefly advert to it. An explanatory sketch prepared by the Divisional Engineer for the information of the Commission and the whole testimony of the witnesses show that the breached portion of the embankment was filled up with moorum, coal-ash and boulders. Three feet of moorum was put in first, then coal-ash and earth were dumped, then some boulders were dumped along with coal-ash, earth and moorum. The height at that stage was about 3 feet short of the rail level. Sleeper-cribs were then put up. There were 8 layers of sleepers in each crib. The bottom layer was laid with sleepers butting each other. Further layers were criss-cross and the top layer of the sleepers laid correctly up to the track. The crib was 6 feet square and 3 feet high. The restored track was strengthened by interlacing wooden sleepers with the steel trough sleepers. According to the Divisional Engineer, when he passed the heaviest type of engine, the YG, over the restored portion there was hardly any settlement. Lifting and packing continued after the repairs were completed on 2nd August, 1956, and traffic was restored. On 2nd August, the speed restriction

was 'Stop Dead and 5 miles per hour'. This was relaxed to Non-Stop 10 miles per hour on 9th August and to 20 miles per hour on 13th August. Normal speed of the section was resumed on 21st August. Between 21st August and 31st August, there was about 5 inches of rain. On one of these days, the rainfall was about 1·2 inches, but there was no settlement between 21st and 31st August. The Deputy Chief Engineer was also questioned at some length about the method adopted in the restoration work. He stated that this method had stood the test of time. When asked about the use of coal-ash in restoration work of the embankment, he stated that this well established procedure had in fact been followed in the case of more serious breaches and where the embankment was exposed to about 200 inches of rain every year. In the case of breaches on 1st August at bridge 229, he would himself have followed the same procedure in restoration work as was adopted by the Divisional Engineer. On consideration of the whole evidence I am satisfied that there was no defect in the execution of the restoration work of the approaches after the washaway of 1st August.

Bridge was structurally sound

There is satisfactory evidence and data which go to establish that the bridge was structurally sound before the accident of the 1st/2nd September. The structure of the bridge had been examined in detail by the Divisional Engineer and the Assistant Engineer. After the washaway of the 1st August, they found the bridge structure to be in excellent condition. There were no cracks; nor had the pointing of the masonry been in any way disturbed. There was no scour and the flooring was found undamaged. The Chief Engineer and the Deputy Chief Engineer examined the undamaged portion of the bridge after the accident and the portion of masonry that survived was found to be in sound condition. The Section Register shows that no structural defects in this bridge had been noticed at any time. Extracts from the Section Register and the Bridge Inspection Register are annexed to the Proceedings. I may add that the Government Inspector of Railways, when he examined the bridge after the accident, reached the conclusion that structurally the bridge was sound.

Removal of speed restriction on 21st August 1956

Removal of the speed restriction on 21st August 1956 over the restored approaches of the bridge after the washaway of 1st August was another factor which, in the context of the date of the accident (1st/2nd September 1956), required to be considered. But I do not propose to dwell on this point or discuss the relevant evidence since the propriety of the decision to lift the speed restriction of 20 M.P.H. which had continued from 13th August 1956 to 21st August 1956 has not been questioned by anyone. I accept the evidence of the Railway Officers on this point. I am satisfied that nothing unusual can be said to have been done when the speed restriction was removed after 19 days of restoration of through running and that in doing so the normal procedure had been adopted. It cannot be said on the evidence on record that it was necessary to enforce any speed restriction after 21st August.

Ventway was inadequate

There has been no controversy before me on the question of the adequacy or otherwise of the ventway of bridge 229 to accommodate a discharge of flood water resulting from 2 to 2½ inches of rainfall in one hour or a little over one hour in the catchment area of the Nalla. The Chief Engineer and the Divisional Engineer both agreed that the ventway of the bridge could not accommodate the discharge resulting from this intensity of rain. I have already pointed out that Shri Yasin Ali Khan, the Divisional Engineer, in answer to a question put to him, admitted that bridge 229 was not safe for a rainfall of 2 inches per hour in the catchment area. There is also other evidence to show that the bridge was not capable of accommodating the peak discharge resulting from 2 to 2½ inches of rainfall in an hour or a little over in its catchment. Hydrological calculations also lead definitely to the same conclusion. Dr. Rao has described the ventway as utterly inadequate. A wider ventway was vital and it must be concluded that the ventway of bridge 229 maintained by the Railway was inadequate.

Considerations, allied, govern the next question which is—whether the bridge could have withstood the impact of flood-water if on 1st September the consolidation of the approaches had been as strong as it was prior to 1st August; or to put the same question differently, could the bridge have withstood the impact of flood water resulting from 2 to 2½ inches of rainfall in one hour in the catchment area of the Nalla, if there had been no tank in the catchment area and no breach of the approaches on the 1st August. This cannot obviously be a matter of positive evidence and must depend on inferences to be drawn from reliable data about the intensity of the rain that fell on that night. Learned counsel, appearing on behalf of the Railway, argued and with some emphasis that there was no possibility of the embankments, even if they were 40 years old and fully consolidated, resisting the discharge of flood-water that rushed to the Nalla on the night of 1st/2nd September 1956 after the rainfall of about 3 inches in the catchment area after 11 P.M. and before the accident. Nor would the position have been different, so it was said, even if the intensity of rainfall was 2 inches or 2½ inches in one hour. It was stressed that there was sustained flow of flood-water for some considerable time. The argument proceeded that there was overtopping of the railway line by the flood-water and of this there was reliable evidence. The case for the Railway may be stated in the language of the learned counsel:

> "There was much more than 2 inches of rainfall in one hour or a little over one hour. It rained so heavily and there was such a sustained flow of water on the night of 1st September that, even if there had been no breach on the 1st August and the approaches had been old and consolidated, the discharge of flood water would have caused breaches of the approaches to the bridge. There was no possibility of the approaches withstanding the onrush of floodwater."

There is, to my mind, force in this argument. It would be flying in the face of established facts and the hydrological data to which

my attention was drawn to surmise that the embankments might have withstood the onslaught of the flood water if they had remained in their old and fully consolidated condition. After giving consideration to all that was said before me, and fully bearing in mind the fact that the approaches of the bridge after they were restored could only have been "fairly consolidated" as the Divisional Engineer himself described them in his evidence, I have reached the conclusion that the bridge could not have withstood the impact of flood-water even if on 1st September the consolidation of the approaches had been as strong as it was prior to the washaway on 1st August.

Plea of act of God

Founded on the evidence about the intensity of rainfall in the catchment area of bridge 229 and the submission that about 3 inches of rain must have fallen there after 11.00 hours on the night of 1st September, the argument advanced on behalf of the Railway was that heavy rain of such intensity had never fallen in that area during the last 40 years. Some reliance was sought to be placed by learned counsel appearing on behalf of the Railway on the fact that the Highest Flood Level recorded at the bridge in 1938 was only 2 feet, 11 inches from the bed level. The suggestion was that in view of such low flood level there was no reason why the officers of the Railway should have apprehended any heavy rainfall in the catchment area of the bridge. I do not think that the suggestion was well founded. In his evidence before the Government Inspector of Railways, the Deputy Chief Engineer was specifically asked whether having regard to the nature and extent of the catchment he considered that record to be correct. His answer was that he was unable to say whether that level had been exceeded prior to 1938. He, however, admitted the possibility that that level could have been exceeded without being noticed by any patrolman at night time since watchmen had been posted at the bridge only in 1955. The Divisional Engineer also in his evidence stated that it was difficult to say whether the recorded Highest Flood Level was correct or not. Bheemadu, the night watchman, very frankly stated that he was not really concerned with the black line by which he meant the Highest Flood Level but was concerned with the red line indicating the pre-determined flood level which was in this case one foot below the bottom of the girder. I may observe that the level of 2 feet, 11 inches would be reached with one-fourth of an inch of rainfall in the catchment area in an hour taking 70% run-off. In my opinion Dr. Rao is right in his observation that the Highest Flood Level was absurdly low. It was not suggested and could not be suggested that rain with much greater intensity than this must not have fallen in the catchment area. There was no justification for any officer of the Railway to rely on this low level and I do not think any one of them in fact did so or attach any importance to it. I have no doubt that the flood level under the bridge must have risen to much more than 2 feet, 11 inches on previous occasions but no one cared to notice it because the water probably must not have reached the level of the girders. It is to be remembered that water rises very suddenly in this area with its steep gradient and no watchman had been kept at the bridge before 1955.

The argument proceeded that the rainfall was unprecedented and abnormal and resulted in a sustained flow of flood discharge which came rushing to the bridge which had been designed to accommodate only about 2,400 cusecs of flood water and overtopped the railway line. There was definitely an overflow, so it was stated, of about six inches to one foot of water on the railway line which necessarily caused breaches at the approaches of the bridge. This extraordinary rainfall and heavy discharge, it was urged, amounted to an act of God because the possibility of any such downpour could not reasonably be anticipated and provided for by those who maintained the bridge.

This plea of act of God require to be carefully examined. Act of God, which is a species of the larger genus "inevitable accident", is an event or occurrence due to natural causes directly and exclusively without human intervention which could not have been prevented by any amount of foresight and reasonable care on the part of anyone. To the meaning of this untheological expression, theological colour was given when it was spoken of by the House of Lords as "unresistible and unsearchable Providence nullifying all human effort". For the present purpose, it will suffice to refer to its well established meaning "circumstances which no human foresight can provide against and of which human prudence is not bound to recognise the possibility". Distinction is at times sought to be made between frequency or otherwise of an occurrence in the light of its violence. But it is only one of degree and not of kind. The violence or rarity of events is relevant only in considering whether it could or could not have been prevented by reasonable care and foresight. It is indubitable that one sought to be held responsible in any case of operations of natural forces, is absolved from responsibility or liability if he establishes that the unpredictable nature of the occurrence was one which he was under no duty to foresee or provide against.

That it was the duty of the Railway to provide an adequate ventway for the bridge has not been questioned. Nor has it been questioned and indeed it was conceded in their evidence by two Senior Officers of the Railway, the Chief Engineer and the Divisional Engineer, that bridge 229 was not capable of resisting the discharge of flood water resulting from even two inches of rainfall in one hour in its catchment area. It is true that two inches of rainfall in one hour does not appear to have fallen in this area for the past many years for, if that had happened, the height attained at the bridge by flood water in the wake of such rainfall could not have gone unnoticed. It was emphasised by Shri Rajaram that the rainfall must have been about 3 inches in an hour or a little over an hour and that was unprecedented and abnormal. In this connection, reliance was also placed on the evidence of witnesses from villages in the proximity of the Nalla. Now one flow underlying this argument is that it confines the view only to the immediate area of the catchment. I do not think that you can rightly confine your view to that area. No one has said that such rainfall was unprecedented in the region of Mahbubnagar; and I think that the engineers of the Railway were bound to consider that on some day the catchment area might be subjected to the same rainfall as other places in the region of Mahbubnagar and its vicinity. The rainfalls recorded at Mahbubnagar on one day

in September 1949 and on another day in September 1954 were 5·25 inches and 5·37 inches respectively. Shri Hardikar in his evidence stated that the intensity of rainfall at Atmakur which is about 20 miles from Mahbubnagar was 9·5 inches on 23rd May 1952. It is true that the intensity of rainfall per hour in any of these cases is not recorded, but the intensities illustrated above and others which I have already mentioned do go to show that there was no sound reason for assuming that 2 to 2½ inches of rain was not likely to fall in one hour in the catchment area of the Nalla. In the present context, it makes little difference whether the rainfall in that one hour or a little over one hour was 2 to 2½ inches as I am inclined to accept, or was about 3 inches as the learned advocate for the Railway has submitted. I put to myself the question: Was this 2 to 2½ inches of rainfall in one hour or a little over one hour such a convulsion of nature that it must be regarded as the cause of the accident directly and exclusively without human intervention and such that the accident could not have been prevented by any amount of foresight and care that could reasonably be expected from the Railway?

The mere fact that nothing similar was experienced since the construction of the bridge in 1916 is not enough. It must also be shown that it is improbable that such a thing would occur. The principal consideration is whether human prudence was bound to recognise the possibility of such an occurrence and if so, could the accident have not been prevented by foresight and reasonable care on the part of the Railway. It was stressed that this rainfall was extraordinary because nothing like it had happened in the last 40 years. It might perhaps have been said, on the other hand, that what was remarkable was that in this area two inches of rain had not fallen at any time in one hour. It is not disputed that no railway authority whatever had at any time thought of the possibility of even two inches of rainfall falling in one hour in this area. Dr. Rao has given the opinion that the ventway was utterly inadequate to cater for an intensity of even two inches of rain per hour. In my opinion, inadequacy of the ventway is a crucial consideration. The fact having been conceded and also otherwise proved, there is not much scope for saying that this was a case of *damnum fatale*. Whether proper precaution was taken or not by keeping a watchman and whether in fact the bridge was properly watched on the night of the accident are in the present context not effective considerations. And even if they were, it is not possible for me to say that there was adequate watch kept on the bridge on the night of the accident as I shall point out later on in my Report.

The view I take of the matter is that rainfall in a particular place might be so heavy and unique that it must be regarded as an unpredictable convulsion of nature and therefore an act of God. But for reasons I have already discussed I am unable to see my way to treat this rainfall as so overwhelming or such a convulsion of nature that its occurrence was one that the Railway was under no duty to foresee and provide against. This view humbly appears to me to be in entire accord with juristic view. But I do not intend to give any undue legalistic colour to this discussion and do not propose to burden this Report with forensic opinions. I shall only refer to one decision of the Judicial Committee of the Privy Council Great

Western Railway Company of Canada *v.* Braid, 1 Moo. P.C.C. 101. In that case a Railway Company was held liable for injury shown to have arisen from the improper construction and maintenance of the Railway. An accident to a train had occurred owing to an embankment which had stood firm for 5 years giving way after heavy rains. It was argued on behalf of the Railway Company that there was an uncommonly severe storm. It was also pointed out that they had employed competent and skilful engineers to construct the line and there was no suspicion of insecurity about the embankment which had been daily inspected by competent surveyors and engineers. In delivering the judgment of the Board Lord Chelmsford observed at pp. 120, 121:

> "Their Lordships, without attempting to lay down any general rule upon the subject, which would probably be found to be impracticable, think it sufficient for the purpose of their judgment in these cases to say that the Railway Company ought to have constructed their works in such a manner as to be capable of resisting all the violence of weather which in the climate of Canada might be expected, though perhaps rarely, to occur. Now, the evidence fairly considered shows nothing beyond this in the character and degree of the storm which destroyed the embankment. The night of the accident is described by various witnesses to have been "very severe"; one says it was a "bad night, very bad"; another, in the usual style of exaggeration, that "it was the worst night he ever saw;" it is stated by others that the rain "washed away bridges and portions of the road;" and two of the Plaintiff's witnesses describe the storm, one, as being "a very unusual one", the other "an extraordinary storm." In the whole of this evidence there is nothing more proved than that the night was one of unusual severity, but there is no proof that nothing similar had been experienced before, nor is there anything to lead to a conclusion that it was at all improbable that such a storm might at any time occur. It must also be borne in mind that although the embankment had stood firm for five years, and had possibly not been exposed to any storm of equal violence to that before which it gave way, yet it was evidently not constructed, or at least not maintained, in a manner to enable it to resist any unusual pressure."

I am conscious of the fact that there are and there must be limits to what a Railway can be expected to foresee and to provide against in the matter of construction and maintenance of bridges with reference to their capacity to withstand flood water. But I do not see how that consideration can exonerate the Railway on the ground of *Vis Major* in the situation that has here arisen. I should like to make it clear that I am concerned here with a culvert having a small drainage area and not with a bridge over a river having a large catchment area. I fail to see how in this situation the rainfall of the intensity of 2 to 2½ inches in one hour, in a hilly terrain which is fairly thickly wooded and is close to Mahbubnagar where the average annual rainfall recorded in the last 10 years has been 36·64 inches, the lowest being

29·80 inches and the highest being 45·87 inches, can be regarded as *force majeure.*

Plea of inevitable accident

Nor is there any room here for the application of the wider doctrine of inevitable accident. It was contended that the unprecedented and extraordinary downpour of rain in the catchment area in the short period of one hour or a little more and the sustained flow of flood water that resulted, rendered the washaway of the embankments inevitable, in view of the capacity of the bridge to cater for only 2,400 cusecs of water. It was stressed that the ventway of the bridge had been designed by a skilled engineer. Proper precautions were taken and but for the fact that Bheemadu was late by about 15 minutes the accident could have been averted. Now an inevitable accident must be an event or occurrence which is one out of the ordinary course of things, something so unusual as not to be looked for by a person of ordinary prudence. It is well established law that in order to sustain the plea of inevitable accident it must either be shown what the cause of the accident was and that the result of that cause was inevitable or all possible causes must be shown, one or other of which produced the effect, and with regard to each such possible causes it must be shown that the result could not have been avoided. Where negligence is charged and responsibility sought to be laid, it is always a valid defence that the accident was inevitable. But this defence of inevitability is only possible where there is no want of reasonable care or skill and it cannot be said that the loss was caused by any act or omission of the party sought to be held responsible for the same. The test to be applied here, therefore, is: Can it in the facts and circumstances of the accident under consideration be said that it could not have been obviated by reasonable care, caution and skill on the part of the Railway? Inevitable accident implies an absence of all blame on the part of the party sought to be held responsible on the ground of negligence. There is no inevitable accident where there has been negligence. A railway is bound to bear in mind, in constructing and also thereafter in maintaining its bridges, the risk of very heavy rain and severe operations of nature which are still not beyond the reasonable foresight of men and within the power of skilled engineers to resist. Where there is a duty to advert to the consequences of any act or omission failure to do so imposes liability.

It is established that the ventway of the bridge was utterly inadequate. The precaution taken in the matter of keeping a watch at the bridge, as I shall point out later on in my Report, was also inadequate. In examining the plea of act of God I have already discussed most of the circumstances that were relied upon in support of the present contention of the Railway and need not repeat what I have said before. In the light of all this, it is not possible for me to accede to the plea of inevitable accident.

It was suggested in the course of the arguments by Shri Rajaram that extraordinary skill was not required to be exercised by the Railway in the matter of construction and maintenance of the waterway of bridges. I agree that one cannot insist upon any extraordinary measures or demand any standard of absolute safety amounting to

insurance for any risk foreseeable or not. But such cannot be said to be the case where the circumstances show that likelihood of danger could have been foreseen with reasonable care and prudence. I do not suggest that proof of consummate caution or extravagant precautions should be insisted upon before the plea of inevitable accident is sustained.

Grouping of bridges 229 and 233

The necessity of a close and special watch being kept at bridge 229 was not disputed by the Railway. Question arises: Whether watch kept at the bridge on the night of 1st September was adequate? Question also arises: Was it safe and prudent to group bridges 229 and 233 for being looked after by a single watchmen? In the evidence of the Deputy Chief Engineer there was a qualified suggestion that some responsibility for the failure of the watch might perhaps rest on Shri Bheemadu, the night watchman. The Deputy Chief Engineer admitted that till he himself gave his evidence before me no railway authority had made the suggestion that Bheemadu, the night watchman, had been negligent in his duty on the night of the accident. The Deputy Chief Engineer's evidence on the point amounts to this that Shri Bheemadu failed to protect the passenger train because he was delayed at bridge 233. The cause for the delay, as the Deputy Chief Engineer said he had found out to be approximately 15 or 20 minutes, was that Shri Bheemadu's attention had been attracted by a red signal shown from Mahbubnagar direction while he was at bridge 233. He stated that he would blame Shri Bheemadu only if he had stayed at bridge 233 unnecessarily but on this occasion he was delayed at bridge 233 by the red signal (given by patrolman No. 3) from the other direction. The Chief Engineer, however, was emphatic in his evidence that Shri Bheemadu should not have waited at bridge 233. It was said that he had first-hand knowledge of the fact that the approaches of bridge 229 had been washed away only a month previously and he should have, therefore, quickly returned to bridge 229 to ascertain the condition at that bridge. It is to be noticed that apart from this fact of Bheemadu having waited at bridge 233 for about 15 or 20 minutes more than he should have done, there is no suggestion that there was any other lapse on his part in keeping watch on that night. I have already analysed the evidence of Shri Bheemadu and Patrolman No. 3. It is not possible to state with any precision the time Shri Bheemadu must have spent in going from one bridge to another and the time spent by him at bridges 229 and 233. This much, however, is clear that he had completed his first beat that night before 9 P.M. when he saw a goods train pass over the bridge. It has been ascertained that the goods train passed bridge 229 at about 9 P.M. on the night of 1st September. It also appears that he started his second beat after spending considerable time at bridge 229 for it was at about 11.30 P.M. that he had gone to bridge 233 for the second time that night. After sometime he noticed a danger signal shown by Patrolman No. 3 from Mahbubnagar side and clamped detonators on the rails at Mile 67/10-11. In his evidence before me he stated that after he saw the red signal from the other direction he did not run back to bridge 229 because he was under the impression that there was nearly an hour to go before the passenger train was expected.

Bheemadu not responsible for the accident

It is impossible for me in these circumstances to hold that Bheemadu was responsible for the failure of watch at bridge 229 on the ground that he should not have waited at bridge 233 for .15 or 20 minutes after he saw the danger signal from Mahbubnagar side because he should have realised that the Passenger Train was due to reach bridge 229 within a few minutes, and immediately gone back to bridge 229. The suggestion that the direct cause of the accident could be regarded as Bheemadu's justified or unjustified absence from bridge 229 a little longer than it need have been, is not in my opinion one which can prevail in the facts and circumstances of this case, In applying the basic test of the 'reasonable man's care', accent is not laid on any such refined calculations of time but on practical considerations and the standard of care required in the facts and circumstances of the particular case. On the question of adequacy of the watch the vital consideration, therefore, is why was Shri Bheemadu not at bridge 229 to protect the passenger train and not merely whether he should or should not have remained for some time at the other bridge. This aspect of the matter must be considered in the entire context and the question whether grouping of bridges 229 and 233 for being looked after by the watchman was safe and prudent or not has substantial bearing in applying the standard of care which is the basis of the law of negligence and is determined by balancing facts relevant to the danger sought to be protected against and the expedience of the course pursued.

Argument for the railway

I shall now refer very briefly to the precautionary measures, which, as pointed out by learned counsel, were taken by the Railway after the Jangaon accident. It was said that these consisted of posting of day and night watchman, intensive patrolling and supervision by railway officials. It was further said that after the Jangaon accident, all possible precautions that could be thought of had in fact been taken and it was despite all care and caution that the unfortunate accident at Mahbubnagar had occurred. The protective measure of patrolling could not afford any effective safeguard to the bridges because a patrolman on his beat would pass a bridge only four times at night and that at long intervals. This was realised and the argument rested on the safeguard afforded by posting of watchmen specially employed for keeping vigilant watch. It was argued that day and night watchmen were posted at all vulnerable places and there was nothing objectionable in grouping certain bridges for the purpose of being looked after by one watchman. This grouping of bridges for watch, as I shall presently point out, was in fact done in case of bridges which had past history and which were tank-affected. It was said that the main factors considered in grouping of bridges were proximity to each other and conditions at site. On a number of occasions watchmen looking after grouped bridges had stopped trains. It was added that under the existing system of grouping of bridges watchmen were posted exclusively on as many as 156 bridges on the former Nizam's State Railway. But those bridges were at such distances that they could not possibly have been grouped on the ground of their being within a distance of about a mile from one another and there was no suggestion

therefore that those bridges could in fact have been grouped and were yet not grouped. It was stressed that on the railway track of the Secunderabad Division of over 1,400 miles there were 310 tank affected bridges and 165 bridges with past history. The argument was that in case of bridges lying within the distance of a mile grouping was justified in view of this large number of tank-affected bridges and bridges with past history existing on the ex-Nizam's State Railway.

Precautionary measures after Jangaon accident

Certain precautionary measures had been in force on the Central Railway for many years prior to the Jangaon accident. It appears that after that accident it was realised that more elaborate precautionary measures were necessary in the interest of safety. Mandatory instructions and directives, which I have already mentioned in the introductory part of this Report, were given by the Railway Board by its letter of 2nd December 1954. These from their very nature could only be pointers and on broad general lines and the implementation of them had of necessity to be left to the various Railways. Written instructions were required to be issued by the Deputy Chief Engineers, in respect of circumstances that may endanger the safety of bridges. Public safety was to be ensured in all circumstances.

By a circular letter of 13th November 1954, the Chief Engineer directed certain enquiries and investigations into vulnerable locations and invited proposals from Divisional Engineers for remedial measures for the safety of bridges with past history. This was to be expedited as action was intended to be taken before the next monsoon. It was felt that it could not be possible to complete all the remedial measures before the monsoon and the instruction was:

> "Where, owing to the extensiveness of remedial measures to be carried out and/or owing to the difficulty or complexity of execution, it is not possible to carry them out before the next monsoons, it will be necessary to employ special watchmen at such vulnerable points to keep a vigilant watch during the monsoons and/or to impose speed restrictions over such locations.....

Watch at tank affected bridges

Watch was directed to be kept at bridges in whose catchments irrigation tanks or canals were situate as it was felt that they were liable to breaches due to heavy rains. In respect of such bridges, the instruction was:

> 'In the case of such bridges, it is necessary to keep a special watch during the rains, and this should be done by employing two watchmen at each of such bridges, one at each end of the bridge, by night, during the monsoons. During day time one watchman should be enough....."

Modification of instructions

Some modifications of these instructions were subsequently made by the Chief Engineer by his letter of 10th May 1955. The instructions relating to employment of special watchmen at vulnerable

points remained the same as before but in the case of bridges in whose catchments were situate irrigation tanks or canals, he directed that the number of watchmen to be employed could be reduced by grouping adjacent bridges which were 'within a distance of say, one mile'. The propriety of this decision may be questioned. So far as these two circulars go, the instructions were that grouping of bridges within a distance of one mile could be made only in case of those which were tank or canal affected. In the case of bridges with 'past history', that is, those where damage had previously been caused by flood, no grouping was directed and there was to be vigilant watch by day and by night.

Decision to group bridges

An unfortunate decision relating to grouping of bridges in general was taken by the Chief Engineer prior to the monsoon of 1955. What happened may be stated in the words of the Deputy Chief Engineer in his evidence before me:

> "Grouping of bridges was decided on the following considerations. When lists of bridges that were required to be watched were received from the Divisional Engineers, it became known that a number of small bridges which were required to be watched during the monsoon were situated close to each other. It was thought that these bridges could be regrouped over short beats and watched effectively. It is also known that the intervening formation between such bridges is susceptible to damage and therefore the added advantage of grouping in short beat is that not only the bridges and their approaches could be watched but the intervening formation also. In fact with this arrangement and the monsoon-patrolling system in vogue these short beats received intensive patrolling and watch. The workability and practicability of this arrangement was given due thought and consideration and it was then decided to group such bridges within a distance of one mile. Actually, bridge No. 229 and bridge No. 233 were situated at a distance of 0·6 mile from each other."

In support of the revised arrangement for grouping the Deputy Chief Engineer went on to say:

> "The bridge watchmen are required to be vigilant during their duty hours. This does not mean that they must be walking up and down all the 12 hours they are on duty, but they are required to walk up and down as frequently as possible, being extra-vigilant when it rains heavily or when the level of flow of water in the waterways of bridges rises. They are also required to be extra vigilant when information about heavy rainfall on receipt of weather warning telegrams is conveyed to them. This does not happen every day. This arrangement is satisfactory and workable as can be judged by the fact that on Secunderabad Division alone, bridge watchmen had protected the track on 31 occasions during the monsoon of 1955 and on 29 occasions, during the monsoon of 1956.

Of these occasions, watchmen in charge of grouped bridges have protected the track 15 times in 1955 and again 15 times in 1956....."

I asked him:

"Will you agree that the period of duty of night watchmen being 12 hours even on a rainy night, there will always be the probability of his not being able to keep a close watch on one bridge for a period of about 2 hours due to his absence from that bridge?"

His answer was:

"The probability is there."

The Chief Engineer in answer to a question put by me about this grouping of bridges stated:

"I submit that grouping of bridges was not mandatory but was permissible when bridges which required watch were within a distance of about one mile. The Divisional Engineers were expected to take local factors into consideration when arranging for watchmen to watch bridges in groups. When bridges in the vicinity of each other are liable to be damaged by floods the intervening formation is also likely to be affected by the floods. On the very night of 1-9-1956 the embankment at Mile 68/5-12 between bridges Nos. 237 and 238 was breached and this damage was detected by the watchman detailed to watch the small beat from Mile 68/1 to Mile 68/13."

Then I asked him:

"Do I understand that according to you keeping of one night watchman for bridges 229 and 233 was not an error?"

His answer was:

"I say it was not an error."

In his evidence before the Government Inspector of Railways, the Divisional Engineer stated that the beat of watchmen for vulnerable bridges was upto one mile or less. One watchman was posted by day and one by night. It was the duty of watchmen to move up and down the beat keeping a watch over the bridges. The limit of one mile was fixed by the Chief Engineer when he modified by his letter of 10th May 1955 instructions given in an earlier letter, dated 13th November 1954. At no time more than one watchman had been provided for bridges 229 and 233. When asked whether he considered that there would be sufficient time for the watchman to go from bridge 229 to the other bridge, examine the same and come back to be in a position to protect an approaching train, his answer was that the bridge had no previous history after 1st August 1956 and as the cause of the breaches on 1st August 1956 had been definitely established, viz. the bursting of the tank, the bridge no longer remained vulnerable and there was no question of anticipating any sudden rise of flood water as had happened on 1st August 1956.

The distance between the two bridges was less than 2/3rd mile and the watchman could easily go from one bridge to another and be in time to protect a train approaching from any side. On being further questioned as to why he continued the night watchman for bridge 229 when the bridge, according to him, had ceased to be vulnerable, he said that the approaches to the bridge had been newly repaired and the watchman was expected to look after newly built up approaches in accordance with the instructions given by the Chief Engineer in his letter of 6th July 1956.

Practice followed by Deputy Chief Engineer

It is to be noticed that in the two Circulars of the Chief Engineer to which I have adverted, grouping of bridges was confined to those which were tank or canal affected. But in practice what was actually done was that when the Divisional Engineer in pursuance of the Deputy Chief Engineer's letter of 17th December 1954 sent a statement of bridges on the Secunderabad-Dronachellam Section, the Deputy Chief Engineer directed grouping of certain bridges within a distance of one mile. These included bridges with past history and bridges which were tank affected. In a number of cases a bridge which carried past history was bracketted with another bridge which was tank affected or which had past history.

It appears from the written opinion given by Shri Mitra, one of the learned assessors, that there was some misunderstanding on his part on this question of grouping as it was actually done and sanctioned. I shall refer to that later on in this Report. It is abundantly clear from the evidence of the Chief Engineer, Deputy Chief Engineer and the Divisional Engineer that grouping of bridges for watch was in fact done and sanctioned in respect both of bridges carrying 'past history' and those which were tank affected. It is also clear from the evidence of the Deputy Chief Engineer that a bridge, the approaches of which had been newly constructed, could be grouped with another bridge if it lay within a distance of one mile irrespective of the latter carrying past history or being tank affected. It is in these circumstances that according to the Divisional Engineer he had grouped bridges 229 and 233 before the 1st August 1956 and after the restoration of the approaches of bridge 229 he continued the same bracketting.

It is in the light of the relevant evidence and the foregoing observations that I proceed to consider whether grouping of bridges 229 and 233 was safe and prudent. It is plain that before 1st August these bridges 229 and 233 were grouped on the ground that they were both tank-affected, although in case of such bridges it was considered "necessary to keep a special watch" by day and by night. Intermittent watch was regarded as safe in case of such bridges lying within a distance of one mile. After the restoration work in the beginning of August 1956 of the approaches of bridge 229, the bridge, according to all the three principal officers of the Railway examined before me, ceased to be vulnerable. They did not even regard it as one carrying past history. But its approaches having been newly restored, the bridge was understood to fall under the category of bridges mentioned in the Chief Engineer's letter, dated 6th July 1956 as requiring "very close watch". Grouping of such a bridge with

another bridge carrying past history or which was tank affected was permissible as must follow from the evidence of these three officers of the Railway.

Some considerations overlooked

Now, the very purpose of this protective measure of posting a single watchman by day and by night during monsoon to keep a close watch at the bridge, the approaches of which were newly restored, was to carry out the express and explicit directive of the Railway Board that public safety should be ensured in all circumstances. The difficulty of movement of the night watchman between any such two bridges and the time that he would take in inclement weather for going from one bridge to another and retrace his beat had of necessity to be carefully considered. It was also necessary to have regard to the hilly nature of one terrain and the distinct possibility of flood water at any one of the grouped bridges or even at both of them rising to a high and dangerous level within a short period of one hour. It was also necessary to bear in mind that there was always the possibility of a night watchman, howsoever vigilant, being away and absent from one of the bridges for nearly two hours. In the context of monsoon conditions and particularly stormy weather, a "special watch", or a "vigilant watch" or a "very close watch" would demand his undivided attention and public safety could be ensured only by posting an exclusive full-time watch. Grouping of bridges in these circumstances was apt if not wholly at least partially to nullify the requirements of an effective watch. In answer to a question put by me, it was frankly admitted by Shri Lobo, the Deputy Chief Engineer, that the probability was there of a night watchman on duty on a rainy night not being able to keep a close watch in such a case on one bridge for a period of about two hours due to his absence from that bridge, but such probability was not present in his mind. It seemed rather strange to me, however, when he immediately added that "There is no end to safety precautions that could be taken". I confess my inability to understand how there is any room here for the consoling thought and excuse sometimes afforded by the saw "there is no end to safety precautions that can be taken". It is obvious that no thought was given to this inherent weakness in the scheme of grouping. It was a risk which should not have been overlooked and was one which should have been seriously taken into account when the principle of grouping was accepted. Unfortunately, it was not realised that in enforcing special and close watch the objective was to take the last possible effective measure against an emergency and that there was the danger in such cases of the arrangement of grouping breaking down and frustrating the very purpose sought to be achieved. The Government Inspector of Railways does appear to have noticed the danger underlying the grouping of bridges for the purpose of being watched by a single watchman. In his Report he has dealt with this point under the heading "Classification and Equipment of Bridge Watchmen". He does not appear, however, to have considered this aspect of grouping of bridges in its bearing on the question of ascertainment of the causes of the accident. After giving careful consideration to all that has been said and every argument which fastened upon the workability and practicability of the arrangement of grouping of bridges in general and the two bridges specifically

in issue, I am of the opinion that the grouping of these two bridges was not safe and prudent.

Principal cause of accident: inadequate ventway

Upon the whole, I have reached the conclusion that the principal cause of the accident was that the ventway of bridge 229 was inadequate to accommodate discharge of flood water resulting from 2 to 2½ inches of rain which fell in the catchment area within one hour or a little over one hour on the night of 1st/2nd September 1956. I am concerned here with a culvert in a hilly terrain having a small drainage area of a little less than five square miles and not with a sizable bridge over a river with a vast catchment over all parts of which high intensities of rainfall are not of simultaneous occurrence. I have already examined the questions of intensity of rainfall and the capacity of the bridge and other cognate matters and I do not intend to go over the ground already covered. Before reaching this conclusion I have given full thought to the opinions of both the learned assessors which they gave at my request. (See Annexures to this Report). Shri Mitra has stated in his opinion that he has enclosed a Note on Dickens' formula but apparently through oversight no such Note has been appended by him. I confess that it is not clear to me as to what Shri Mitra's opinion is on the question of adequacy or otherwise of the ventway of the bridge but it seems to me that he does not agree on certain points with Dr. Rao whose opinion was read by him. With all respect to Shri Mitra I am unable to accept a number of reasons given by him in support of his observations on this question but it is not necessary for me to discuss the same. Some aspects mentioned by the learned assessor can have bearing as mitigative factors but they cannot be permitted to disturb the assessment of the causes of the accident. I do agree with Shri Mitra when he says that "he would be a bold Engineer indeed who would be able to guarantee 100% security against all floods and their effect on railway banks and waterways and yet design his works on rational and economical basis". Now I do not expect any railway or any engineer whose duty it is to construct and maintain railway bridges to guarantee 100% security against all floods and their effect on railway banks and waterways. Nor do I find anything in the opinion of Dr. Rao that would suggest such cent. per cent. requirement or any reasoning that militates against any principle or maxim of the dynamics of floodwater. Nor can it be said that the Railway Board demanded any such absolute standard of safety when by its circular letter, dated 2nd December 1954 it enjoined the railways to ensure "public safety in all circumstances". It was suggested in the course of his arguments by Shri Rajaram, learned counsel for the Railway, that extraordinary skill was not required to be exercised by the Railway in the matter of construction and maintenance of waterways of bridges. I agree that one cannot insist upon any extraordinary measures or demand any standard of absolute safety amounting to insurance against every risk. But such cannot be said to be the case where the circumstances show that likelihood of danger could have been anticipated with reasonable care and remedial measures could have been taken by providing an adequate ventway.

A railway is bound to bear in mind in maintaining its bridges, the risk of very heavy rain and severe operations of nature which

are still not beyond the reasonable foresight of men and within the power of skilled engineers to resist. Hydrological calculations based on careful selected and, if I may say so, conservative data were made by Dr. Rao. He has said that the bridge ventway was utterly inadequate to carry 4,000 cusecs of flood water and that the principal cause of the accident in his considered opinion was the heavy concentrated rainfall of about 2 inches per hour or over in the catchment area and the insufficient ventway of the bridge. More I do not intend to say. Before arriving at this result I have also considered all that the Government Inspector of Railways has said in his Report about the capacity of the ventway and unprecedented rainfall, but it is not possible for me to reach the less distressing conclusion that the accident was inevitable or to dismiss it as *damnum fatale.*

Another cause of accident: inadequate watch

I have also reached the conclusion that another cause of the accident and one which has also required serious consideration was that the watch kept at bridge 229 on the night of 1st September was not adequate because it was not safe or prudent to group bridges 229 and 233 for being looked after by a single watchman. This grouping, of necessity, meant divided attention by the night watchman at two vulnerable spots at a distance of about ⅔rd mile from each other. I have already examined this question of bracketting of bridges at some length and expressed the view that the watch kept at the bridge was inadequate and that the reason for this must be found in the arrangement of grouping bridges lying within a distance of about one mile and not in the absence of the watchman from bridge 229 in the emergent situation that suddenly arose. It was not safe or prudent to group bridges 229 and 233. That in my opinion was a serious mistake. The paramount and indispensable consideration of safety made it obligatory that in every case where a bridge or its approaches required attention and that too in a terrain of the nature to be found in this Section of the Railway where there was the possibility of flood water suddenly rising, close and continuous watch should have been insisted upon as the ultimate safeguard. That principle of safety was trenched upon when vulnerable bridges which required close watch were grouped for being looked after by a single watchman. The inadequate ventway notwithstanding the accident could certainly have been avoided if the ultimate safeguard of close and continuous watch had been enforced.

Railway responsible for the accident

It is for these reasons, which I have sketched, that the Central Railway must be said to be responsible for the accident. Omission by the engineering department of the Railway to maintain an adequate ventway for the bridge and omission to enforce full-time watch at the bridge during monsoon before remedial measures could be taken, renders the Railway responsible on the ground of negligence. The rainfall proved to have occurred at the period of the accident was no doubt heavy, but it cannot be regarded as of unique character or an unpredictable convulsion of nature. It was such as ought to have been foreseen as possible. Having regard to the hilly terrain, the meteorological data available for Mahbubnagar and its vicinity and the other relevant facts which I have already discussed, it is not possible for

me to take the view that 2 inches to 2½ inches of rain in one hour or a little more than an hour in the catchment area of the Nalla was an act of God. Nor is it possible for me to accede to the suggestion that this was a case of inevitable accident. An adequate waterway was of vital importance and till remedial measures were taken it was equally vital to see that close and continuous watch was maintained at the bridge. Grouping for the purposes of watch of two vulnerable bridges lying at a distance of about ¾rd mile was a serious error. There are mitigative factors but they are apart and do not disturb the finding of negligence, though in fairness to those responsible for the accident it must be added that those factors would have considerable bearing on other matters.

Persons responsible for the accident

It remains to consider the question of the person or persons responsible for the accident. In view of the conclusion reached by me that there was an omission to take proper remedial measures in respect of bridge 229, the first thing to be examined is: Whose duty was it to see that the Railway maintained an adequate ventway for the bridge? Now primarily it was for the Chief Engineer and the Deputy Chief Engineer to apply their mind to the question of stability of all bridges on the old Nizam's State Railway after it was merged in the Central Railway. It was for them to direct investigation into the question and especially so after the experience at Jangaon. The Railway Board's letter of 2nd December directed the attention of the Deputy Chief Engineer not only to bridges with past history but also to "others considered necessary" and satisfy himself that the bridges would remain safe under flood conditions. Then came the recommendations of the Government Inspector of Railways in his Report on 17th December 1954 after an Inquiry into the Jangaon accident. One of the recommendations was that—

> "the stability of all bridges should be investigated in the light of the maximum possible flood and action where wanting should be taken."

In answer to question put by me, the Deputy Chief Engineer stated that it was true that after the Jangaon disaster it was realised that the span of the bridge that had collapsed was inadequate and added that a decision had been taken to enlarge that bridge. Then I asked him:

> "At that time was it realised that the bridges on the ex-Nizam's State Railway required to be considered from the hydrological point of view?"

His answer was in the affirmative. He added that waterways of some bridges had been extended. I asked him:

> "After the Jangaon accident, did you not think it advisable to direct an immediate enquiry into the discharge of water through bridges in this hilly terrain where a large number of bridges exist?"

His answer was that he had initiated action after checking up waterways of all bridges with past history and the work of extending the waterways of 12 bridges had been completed and sanctions had

been communicated in a few more cases. In answer to another question put by me, he admitted that he had confined the enquiry about the discharge of water through bridges in the Section only to bridges with past history. He, however, added that there were 169 bridges with past history to be checked on the Secunderabad Division.

It was most unfortunate that even though the Government Inspector of Railways had made the specific recommendation set out above, it was not thought necessary to direct at least an enquiry into the condition of bridges lying in this hilly terrain but which did not carry past history. It was urged by learned counsel appearing for the Railway that remedial measures of the nature of extension of waterways were bound to take considerable time. I can understand that priority had to be given to the case of bridges with past history and extension of waterways in case of such of those as required immediate action. But I fail to see why that should have prevented any effort in the direction of obtaining some reliable information about other bridges by instructing the Divisional Engineer to collect some hydrological data about them. If any such investigation had been directed, the true position about those bridges including bridge 229 could have been easily ascertained. The fact that the bridge was utterly inadequate to accommodate discharge of flood water resulting from anything of the order of even two inches of rainfall in one hour allowing 70 per cent run off would certainly have been revealed. In answer to a question put to him, the Chief Engineer agreed that examination of adequacy of waterways of bridges in hilly terrain such as existed on the ex-Nizam's State Railway should have been started after the Jangaon accident. He added that soon after the accident he had initiated investigations and taken some action to provide adequate waterways. But all that was confined only to bridges with past history.

I do not intend to be understood to suggest that the Chief Engineer or the Deputy Chief Engineer should have undertaken a hydrographic survey. Nor do I suggest that they should have immediately after the Jangaon accident directed any elaborate investigation of bridges requiring a very long time to complete. Although priority had to be given to those of the bridges with past history which required immediate remedial action there was no reason for not giving reasonable attention to other bridges in this hilly terrain. If this had been done, general information which did not require lengthy and complicated calculations could certainly have been secured. Information about the catchment area of such other bridges and possible intensities of rain in such area would have drawn their attention even on such *prima facie* data to the true position about those bridges. That information I have no doubt would have brought out the necessity of exclusive and close watch on some of those bridges till fuller attention could be given to them and decision taken as to whether any extension of waterway was necessary in the interest of safety. But unfortunately, nothing of this nature was done or even attempted during the period of nearly two years that passed after the Jangaon accident.

There was additional reason for the Chief Engineer and the Deputy Chief Engineer to start investigation in the matter of the stability of bridge 229 immediately after the breach which occurred on 1st August 1956. The Deputy Chief Engineer was asked:

"Q. : After 1st August did you apply your mind as to whether bridge 229 required any modifications in its structure?

A. : The Divisional Engineer's report of 3rd August 1956 stated that bridge No. 229 carried no past history and that breaches on the approach banks had been caused by the bursting of Pochani kunta and that water overflowed the bridge. It was clear therefore that the abnormal flood was caused by the bursting of the tank and had exceeded the capacity of the bridge. From this it cannot be said that the bridge acquired history and therefore was not included in the list of bridges carrying past history as a result of monsoon floods. It has also been brought out that the H.F.L. had not exceeded 2 feet 11 inches above the floor level since 1937, and that Pochani kunta was lying in a state of disuse for a considerable time, and therefore the catchment was a free catchment, and no abnormal flood had been registered during all that time. The bridge was designed for the run-off from the free catchment area and the necessity for examination of the waterway therefore did not arise. But after the accident we have ascertained the Hydraulic particulars....."

I have already pointed out that the highest flood level was absurdly low and have also pointed out what the Deputy Chief Engineer and the Divisional Engineer had to say about it. If any of these engineers in fact did take that into consideration that was a mistake which should not have been made. It clearly appears from the evidence of all the three engineers that after the 1st August they regarded the bridge as one not carrying any past history. I agree with Shri Mitra when he suggests that 'history' was created when there was a wash-away of the approaches of the bridge on 1st August 1956. But the capacity of the bridge was not taken into consideration and the bridge remained uninvestigated. It was admitted by the Divisional Engineer that to his knowledge no railway authority whatever at any time thought of the possibility of two inches of rainfall in the catchment area of the bridge. The answer of the Chief Engineer and the Deputy Chief Engineer was that in view of the large number of bridges in the Division, they only took up the investigation of bridges carrying past history of which there were 169. But as I have already pointed out there was no sound reason for leaving out other bridges from the reckoning during the whole period of nearly two years after the Jangaon accident. Dr. Rao has stated in his opinion:

"The railway engineers were not aware of the catchment area of the Nalla nor its characteristics. The occurrence of breach on 1st August, if analysed, would have shown the inadequacy of the ventway. The second unfortunate mistake done after 1st August was to assume that complete safety was restored due to the bursting of the tank. Actually the tank, in a good condition, would have been helpful in moderating the floods even though it may not be to any appreciable extent. The bursting of the tank has not added to the safety but rather to the dangers due to great floods. I am of the opinion that the railway engineers in charge prior to the accident have not studied the hydrology of the Nalla and therefore did not realise the utter inadequacy of the ventway in culvert No. 229. This is regrettable specially after the sad Jangaon accident and after the breaches in the same culvert a month earlier."

It was a mistake not to treat bridge 229 as one carrying past history on the ground that it was merely tank affected and the bund having been breached the catchment became a 'free catchment'. It should have also been realised, as Dr. Rao rightly points out, that the bursting of the Tank had not added to the safety of the bridge but added to the danger resulting from a great flood because even the moderating influence of the Tank, though not appreciable, had gone. They merely relied on the report of the Divisional Engineer that no remedial measures were necessary since the bridge had ceased to be tank affected.

Primarily, it was the duty of the Chief Engineer and the Deputy Chief Engineer to see that the ventway of bridge 229 maintained by the Railway was adequate. Investigation of the nature indicated by me should have been started immediately after the Jangaon accident. The fact remains that no attempt was made by them at any time during a period of nearly two years to secure even some *prima facie* data about the catchment area of the bridge and the possible intensity of rainfall. For all the reasons discussed by me in the preceding paragraphs, both the Chief Engineer and the Deputy Chief Engineer must be held to be responsible for the failure to provide an adequate ventway for the bridge.

Responsibility under this head must also fall on the Divisional Engineer. A copy of the Railway Board's letter of 2nd December 1954 had been sent to him. Even if the Chief Engineer and the Deputy Chief Engineer confined their instructions to investigation only of bridges which carried past history, he should have, if not before the washaway of the 1st August, in any event thereafter, seriously applied his mind to the capacity of the bridge and the possible intensity of rainfall. On being asked if he made any investigation or obtained any data about the Nalla after the breaches which occurred on 1st August his evidence was:

> "The breaches were caused by the sudden onrush of water from the tank, which is a very unusual occurrence. The tank had been in operation since 1953 before which it was in disuse for several decades. So the position after the bursting of the tank was the same as obtained in years prior to 1953. During the long periods before 1953 there was no occasion of high floods. There was therefore no reason to apprehend any danger to the bridge under normal monsoon floods. I did not therefore consider it necessary to make fresh technical examination of the hydraulic data.

Q. : Was any attempt made after the 1st August occurrence to determine simple data like catchment area of the Nalla?

A. : I had roughly checked the catchment area from the Ordnance Map and found it to be approximately 4 square miles. This catchment area would discharge normal monsoon flow through the bridge provided there is no unprecedented rain.

Q. : When was this information known to you?

A. : I had done this probably about a week after 2nd August 1956.

Q.: From the catchment area of 4·3 square miles what then did you make out the discharge to be?

A.: 2,250 cusecs."

I am not satisfied with this evidence of the Divisional Engineer. He had been specifically asked by the Government Inspector of Railways:

"Q.: What is the catchment area the run-off from which flows through bridge No. 229?

A.: I was not aware of the catchment of this bridge until it was surveyed 2 days ago. It is understood that the area is 4·3 square miles. The necessity for surveying the catchment did not arise because this bridge had no past history.

Q.: Assuming this catchment, what do you think should be the total run off?

A.: The discharge would be approximately 2,250 cusecs, if Dickens' formula is adopted."

I have no doubt that the Divisional Engineer did not apply his mind at any time till after the accident on 1st September to the question of the capacity of the bridge or its catchment area or the possible intensity of rainfall. Dr. Rao also has, in my opinion rightly, come to the conclusion that the railway engineers were not aware of the catchment area of the Nalla nor its characteristics.

After giving most anxious consideration to this head of omission to provide an adequate ventway for the bridge and take any remedial measures in that behalf, I have, for reasons already discussed, reached the conclusion that the responsibility for the same must rest on the Chief Engineer, the Deputy Chief Engineer and the Divisional Engineer. A number of reasons given by them in their evidence before me in support of their conduct would give rise to valid considerations as mitigating circumstances but they are not such as can exonerate any of them from their responsibility.

I address myself next to the question of the person or persons responsible for the omission to maintain adequate watch at the bridge. I have already observed that it was not safe and prudent to group bridges 229 and 233 for being looked after by a single watchman, and that the principle of safety was trenched upon when these two vulnerable bridges were grouped. I have also pointed out that it was vital that close and exclusive watch should have been maintained at bridge 229 because despite the inadequate ventway of the bridge the accident could have been avoided if this ultimate protective measure had been enforced. Even though it is stated in their evidence by the Chief Engineer, the Deputy Chief Engineer and the Divisional Engineer that the bridge ceased to be vulnerable after the approaches to the bridge had been washed away in consequence of the bursting of the bund of the Pochani Tank on 1st August 1956 and could not be said to carry past history, the view must be taken that the bridge remained vulnerable because its

approaches were newly restored and also carried past history and should have been treated as such.

The few facts relating to the actual grouping of bridges 229 and 233 are these: As required by the Deputy Chief Engineer in his letter of 17th December 1954 the Divisional Engineer sent on a Statement of vulnerable bridges on 16th February 1955. A list of tanks affecting the railway line which had been furnished by the Public Works Department to the Railway had omitted to mention bridge 229. This bridge, therefore, was not shown in the Statement of the Divisional Engineer. The Deputy Chief Engineer passed orders on that Statement as therein shown on 30th April 1955. It appears from the evidence of the Deputy Chief Engineer which I have already set out before that he had a discussion by this time with the Chief Engineer and it had been decided to group not only bridges which were tank affected but also bridges carrying past history provided the bridges under any of these two categories lay within the distance of a mile. This method of grouping also appears from the orders passed by the Deputy Chief Engineer on that Statement. At that time bridges 230 at Mile 67/2-3 and 233 at Mile 67/9-10 were grouped. In May 1955 the Divisional Engineer came to know of the existence of Pochani Tank in the catchment of bridge 229 at Mile 66/15-16. He grouped bridges 229 and 233. Bridge 230 which is a culvert of 2 feet span was deleted when grouping of bridges 229 and 233 was done. It is the case of the Divisional Engineer, as I have already pointed out, that what he had done in the matter of grouping bridges 229 and 233 was in accordance with the instructions given by the Chief Engineer in his various circulars. In the context of these circulars and the circumstances relating to bridges 229 and 233 he considered that adequate watch could be kept by keeping one watchman to look after both the bridges. I have already discussed his evidence on the point and need not rehearse the same.

In view of all this, question arises whether any responsibility for the grouping of these two bridges rests on the Chief Engineer. Now although the directive in the various circulars issued by the Chief Engineer amounted to this that only bridges which were tank affected were to be grouped what was in practice done by the Deputy Chief Engineer was that he directed grouping in case of bridges which were tank affected as well as those which carried past history. That was done by him in accordance with the instructions of the Chief Engineer as he interpreted them. He also understood the instructions of the Chief Engineer in his letter of 6th July 1956 as merely reiterating the necessity of providing close watch on bridges the approaches of which had been remade and not as requiring exclusive watch. In his evidence before me he stated:

> "In my opinion, they do not imply that one watchman by day and one watchman by night should exclusively be posted at each such bridge. His instructions should be read in conjunction with orders already issued previously by him in regard to posting watchmen at bridges having past history and at tank affected bridges which permitted grouping of bridges in short beats. This question was discussed by me with the Chief Engineer and he agreed with this interpretation."

It follows from what is set out above and what I have already discussed that the Deputy Chief Engineer directed grouping of bridges carrying past history and those which were tank affected after consulting the Chief Engineer and ascertaining from him the meaning of the various directions given by him. It also follows from this evidence of the Deputy Chief Engineer that the Chief Engineer had agreed that under his directions in the letter of 6th July it was permissible to group a bridge the approaches of which were newly restored with another bridge which carried past history or was tank affected. The Chief Engineer has not denied this. It also follows that the Divisional Engineer was right in his interpretation of the instructions given to him by the various circulars of the Chief Engineer that it was permissible to him to group bridges 229 and 233 even after the approaches to bridge 229 were restored. There was no suggestion on the part of anyone that in grouping bridges 229 and 233 the Divisional Engineer had in any way acted in contravention of any direction given to him. The Chief Engineer in his evidence before me has, however, stated:

> "I submit that grouping of bridges was not mandatory but was permissible when bridges which required watch were within a distance of about one mile. The Divisional Engineers were expected to take local factors into consideration when arranging for watchmen to watch bridges in groups."

In continuation of the same answer he justified the arrangement of grouping by giving an illustration of its having worked properly on the very night when another watchman at a nearby mileage had detected breaches to intervening formation between two bridges which were under his watch. In answer to the next question put to him, he stated that it was not an error to group bridges 229 and 233. Now the whole trouble has arisen from the decision of the Chief Engineer to group bridges which he permitted to be done in case of bridges with past history as well as bridges which were tank affected. Both the Deputy Chief Engineer and the Divisional Engineer understood his direction to mean that a bridge the approaches of which were newly restored would fall under the same arrangement. The Deputy Chief Engineer had discussed the matter of grouping of bridges with him and the Chief Engineer had agreed that grouping could be done in all such cases. If in these circumstances the Divisional Engineer grouped bridges 229 and 233 the responsibility for the same must in my opinion rest on the Chief Engineer because it was he who laid down the principle of grouping and permitted grouping of bridges falling under the categories of bridges which carried past history, those which were tank affected and those the approaches of which were newly restored. It is not open to me to look merely at the circulars issued by the Chief Engineer and give my interpretation of them. I am bound to take into consideration the evidence of the Deputy Chief Engineer in which he referred to the discussion he had with the Chief Engineer and ascertained that no exclusive watch was directed by any of those Circulars and that grouping was permissible in case of all such bridges. I do not intend to reiterate the considerations which should not have been overlooked before grouping was permitted

and which I have already discussed. It should have been realised that in enforcing special and close watch the objective was to take the ultimate effective measure against an emergency and that there was the danger in such cases of the grouping arrangement breaking down and frustrating the very purpose intended to be served. I have already held that the real cause of the failure of watch at bridge 229 on the night of the accident has to be found in this arrangement of grouping. For all these reasons I have reached the conclusion that responsibility for the omission to maintain effective watch at the bridge must rest on the Chief Engineer. It is not possible for me to take a different view however slow I may prefer to be in the matter of placing responsibility on him.

I turn to consider whether any responsibility for this omission to enforce effective watch at the bridge falls on the Deputy Chief Engineer or the Divisional Engineer or the Assistant Engineer. In view of the broad ground and considerations on which in my opinion this question must be examined and to which I have already referred I do not think the Assistant Engineer was responsible for the failure of the watch. Nor in my opinion can the responsibility fall on the Deputy Chief Engineer. There is nothing in the matter of grouping of bridges 229 and 233 which can be said to have been done or permitted by him. The general directions for grouping originated from the Chief Engineer and all action the Deputy Chief Engineer took in the matter of grouping a number of bridges was after ascertaining from the Chief Engineer the intent of the various Circulars relating to grouping. In view of this, I have reached the conclusion that no responsibility for grouping bridges 229 and 233 can rest on the Deputy Chief Engineer.

The question whether any responsibility for the inadequate watch maintained at the bridge can fall on the Divisional Engineer arises on considerations which require to be distinguished. I have set out the case of the Divisional Engineer on the matter of grouping of bridges 229 and 233 in discussing the responsibility of the Chief Engineer in this behalf. Stated very briefly, the contention was that the Circulars issued by the Chief Engineer were interpreted by him as permissive of grouping a bridge the approaches of which had been newly restored with any other vulnerable bridge and that it was in the context of those Circulars and in the circumstances relating to bridges 229 and 233 that he took his decision to keep one watchman to look after both the bridges. The suggestion was that in doing so he was merely giving effect to the instructions issued by the Chief Engineer in those Circulars. He also stated in his evidence that after the accident the interpretation he had put on the letter of 6th July 1956 was confirmed by the Chief Engineer. Now there would have been some force in this contention if the Divisional Engineer was not expected to exercise his own judgment in the matter of ensuring safety in all circumstances. As the head of his division it was incumbent on him even in the absence of any instructions from the Chief Engineer to take certain decisions affecting protective measures in respect of bridges under his charge. It is no answer for him to say that he received some instructions and merely carried them out. His attention was drawn by the letter of the Deputy Chief Engineer dated 17th December 1954 to

the Railway Board's letter of 2nd December 1954 and a copy of that letter was sent to him. The directives of the Railway Board were to be regarded by him as most urgent and he was requested to give his personal and sustained attention to the same. He was also asked to see that those directions were fully complied with. The instructions and directives given by the Railway Board from their very nature could only be pointers and on broad general lines and the duty to implement the same also rested on the Divisional Engineer in respect of matters within the ambit of his own authority. I have pointed out that close and continuous watch was necessary at bridge 229. And if that be the correct view, it must follow that duty to enforce effective watch rested as much on the Divisional Engineer as on the Chief Engineer. That duty could not be negatived by reliance on certain instructions of a permissive nature given by the Chief Engineer. The Divisional Engineer admitted in his evidence that he gave the requisite directions and sanctions in the matter of employment and posting of watchmen. On a consideration of the whole position, I have reached the conclusion that the Divisional Engineer also was responsible for the omission to enforce adequate watch at bridge 229.

Opinion of Shri Mitra

Before reaching my conclusions on this head of responsibility I have given due consideration to all that has been said by Shri Mitra in his opinion. It emerges that according to the learned assessor the cause of the accident was the inadequate watch kept at the bridge and for this he holds the Divisional Engineer and the Assistant Engineer responsible. Shri Mitra also expresses the view that the Chief Engineer and the Deputy Chief Engineer are not responsible for this accident. I have already made some reference to his opinion on another point. In considering the question of grouping of bridges, Shri Mitra after referring to the Circulars issued by the Chief Engineer and the Deputy Chief Engineer observes:

> "Reading these circulars more carefully, I feel that employment of watchmen for a group of bridges within a distance of a mile was limited to certain divisions only and more specially on the *ex*-N.S. Railway sector, where there was a large number of railway affecting tanks situated near each other. For no other purpose or conditions, grouping has been mentioned and I cannot imagine the object of the Chief Engineer issuing his circular of 6th July if it did not mean an exclusive watchman to be kept on tracks with a new fill, so that he can keep a very close watch on the *behaviour* of such approaches. It is clearly apparent that the Chief Engineer's mind has been working continuously on the matter of safety measures on weak spots in his track and it is quite possible that when we questioned him about grouping of bridges to be watched, he was all the time thinking of the tank affecting portion of his circulars and not where other conditions came in the picture."

Now it is not necessary for me to discuss in my Report the reasons given by the learned assessor in support of his opinion and I do

not propose to do so. But I must observe that on this question of grouping of bridges there has been some misunderstanding about certain facts on the part of Shri Mitra. He is in error when he suggests that the Chief Engineer's mind when he gave evidence before me might have been rivetted only to tank affected bridges and not to other vulnerable bridges. In his evidence the Chief Engineer in support of the principle of grouping gave an illustration of two bridges 237 and 238 which had been grouped with two other bridges. Of these four bridges 237 and 238 were not tank affected but carried past history. I have little doubt that the Chief Engineer knew all along that he was referring to bridges with past history, as well as bridges which were tank affected and also to bridges which required close attention on the ground that their approaches had been newly restored. Shri Mitra appears to have overlooked the evidence of the Deputy Chief Engineer about the Circular letter dated 6th July 1956 issued by the Chief Engineer and the discussion which he had with the Chief Engineer about the grouping of bridges which carried past history and those which were tank affected and also about the meaning of the circular letter of 6th July. Shri Mitra has also overlooked that in the arguments advanced before the Commission by the learned advocate for the Railway, it was stated that bridges with past history as well as bridges which were tank affected were directed to be grouped if they were within the distance of one mile. The learned assessor appears to have remained under the impression that grouping was permitted by the Chief Engineer only in case of bridges which were tank affected and that no other kind of grouping was sanctioned. I had no doubt at any stage of the Proceedings that although the Circular of the Chief Engineer of 6th July directed grouping of bridges only in case of those which were tank affected, what was in actual practice done by the Deputy Chief Engineer, was to group bridges carrying past history and those which were tank affected after discussing the matter with the Chief Engineer. I have looked into the Files relating to grouping of bridges, and satisfied myself that in practice what was done was that when the Divisional Engineer in pursuance of the Deputy Chief Engineer's letter of 17th December, 1954, sent a Statement of bridges on the Secunderabad-Dronachellam Section, the Deputy Chief Engineer directed grouping of bridges within the specified distance of one mile. These included bridges carrying previous history as well as those which were tank affected. A statement prepared from the Files as illustrative of this practice has been appended to the Proceedings.

Opinion of Dr. Rao

Before reaching my conclusions, I have given due consideration also to the opinion of Dr. Rao. The learned assessor confines his opinion to the question of the ventway of the bridge. His opinion is that the principal cause of the accident was the heavy concentrated rainfall of about two inches per hour or over in the catchment area of the bridge and insufficient ventway. He observes that the railway engineers were not aware of the catchment area of the Nalla nor its characteristics. He adds that it is regrettable that even after the Jangaon accident, the railway engineers in charge prior to the accident had not realised the utter inadequacy of the ventway in the culvert.

Suggested safeguards against similar accidents in future

That concludes my Report. But I would in all humility like to suggest some safeguards against similar accidents in future.

The hydrology of all streams affecting the Sector should be studied with all available data and requisite surveys should be carried out. The importance of hydrographic surveys does not require to be emphasised. Hydrographs where feasible are constructed for analysing surface run-off. The advantage of this is that it brings into the frame the element of time which must be a vital factor in the computation of storm flow. It furnishes what is described as the "time of concentration". It was observed in a Paper laid before the Indian Roads Congress by the Bridge Sub-Committee:

> "The basic principle underlying the Hydrograph method is that a continuous rain of constant intensity produces of hydrograph of a characteristic shape for any catchment area, and that this shape and the time of concentration are functions of the shape and size of the catchment area. The shape of the hydrograph is also affected if the duration of the storm either exceeds or is less than the time of concentration."

In case of extensive watersheds, detailed information requisite for hydrographs would often be difficult to obtain and correlate but in case of smaller areas the hydrograph furnishes the best available guidance. But systematic hydrographic surveys can only be a long term plan.

In a vast country like India with its varying weather and climatic conditions the possibility of having a uniform Code of Rules for calculating maximum discharge of rivers and streams may readily be questioned. Various empirical formulae for estimating the discharge from a catchment have been presented from time to time. These run-off formulae from their very nature are of limited usefulness and the generally accepted principle is to devise rational formulae ground on basic concepts.

The immediate practical course to be adopted in these circumstances would be to direct investigations into the hydrology of all streams in the Sector with such data as may be readily available. To start with, catchment areas over one square mile can fairly accurately be determined from topographical maps of the Survey of India. The Public Works Department of Andhra Pradesh, Hyderabad, maintains records of all tanks with irrigation of more than 10 acres. That would also be of use. I would suggest that all culverts should be checked for the maximum flood conditions. For catchments like that of Pochani Nalla the flood discharge should be computed on the basis of the maximum anticipated intensity of rainfall with allowance for a reasonable percentage as run-off. The maximum intensity may be gauged from meteorological records. Results of analysis of severe storms that may have occurred during the past several decades would also have to be considered on the assumption that the storms centre over the catchments. In obtaining this data the Director (Hydrology and Statistics) of the Central Water and Power Commission, Poona, may be requested to furnish relevant data from which the expected intensity of rainfall and storm-depths for any catchment could be estimated.

Any action required for strengthening, widening or rebuilding including resiting of bridges should be taken as expeditiously as reasonably possible. Before action by way of remedial measures can be taken the ultimate safeguard of exclusive and close watch should be strictly enforced during the monsoon.

Grouping of vulnerable mileages is not a salutary principle. Where close and special watch is necessary, bracketting of bridges is most undesirable. In any event in hilly terrains where there is always a distinct possibility of flood-water rising suddenly, full-time watch by day and by night should be maintained during the monsoon.

Before signing my Report I must express my thanks to Shri Mitra and Dr. Rao, the learned assessors, for the assistance and advice they gave me throughout the Inquiry. They were good enough to meet me whenever requested and freely discussed with me points on which I consulted them. On hydrological questions Dr. Rao's advice was of the greatest help and guidance to me. I gratefully acknowledge the very useful and valued help rendered to me by Shri P. B. Aibara, Secretary to the Commission, in all matters of detail and particularly in my endeavour to grasp the hydrological aspects touching questions that arose in the course of the Inquiry. I am indebted to him for the same.

(Sd.) SUNDERLAL TRIKAMLAL DESAI,
Judge, High Court,
Bombay.

24th January, 1957.

OPINION OF SHRI N. K. MITRA,
ASSESSOR.

NOTE

(By N. K. Mitra)

In order to arrive at any conclusion regarding the cause of the accident, the following aspects have to be fully considered:—

(a) Both the approaches of Bridge No. 229 had breached to a length of 31′ and 25′ early in the afternoon of 1st August 1956 as a result of the bursting of the bund of Pochanikunta tank 9,000′ away from the Railway Bridge and rushing of water through a very well-defined Nalla falling down towards the Railway line at a gradient of 1 in 100.

The tank had been out of use for nearly 100 years due to a big breach in the old bund. But a restoration estimate for raising the bund, filling up the breach and construction of a 100′ weir was sanctioned in October 1950 and the tank stored water for the first time in the monsoon of 1953. The storage capacity upto weir level was about 13 million cft. and this would be collected by a rain fall of only about 1½″ in the catchment. The bund had a free board of 12′. The design of the weir allowed a maximum flood discharge of 2,520 cusecs.

The State Government's Rain Gauge at Mahbubnagar recorded total daily rainfall during the end of July 1956 as under:—

18th July 1956	...	1.02″
19th July 1956	...	2.65″
20th July 1956	...	4.00″
22nd July 1956	...	0.60″
25th July 1956	...	2.42″
26th July 1956	...	0.47″
28th July 1956	...	0.84″
29th July 1956	...	0.64″
30th July 1956	...	4.11″
31st July 1956	...	0.32″
1st August 1956	...	1.25″

The breach in the bund, which occurred on 1st August 1956, was 100′ wide and 37′ high on top and 52′ at bottom. At the time of the breach there must have been some surcharge also. A column of water, therefore, $\frac{76+52}{2}$ = 64′-0 wide, 25′ deep had started from the bund and struck the Railway embankment at Bridge No. 229. Here the water rose to a height of 3′ above rail level and the cascaded

water damaged the bank on the down stream side, caused scour and the forty year old well consolidated moorum bank had to give way. This was in day time and the height of water over the Railway line could be ascertained fairly accurately. The patrolman on duty noticing the water rising had stopped an approaching train in good time.

(b) At our inspection on 25th December 1956, we have seen the exposed faces of the embankment (behind the temporary trestles erected since the accident on 2nd September 1956) which consisted of well consolidated hard moorum which has stood the onslaught of the second flood, even though carriages had crashed against it under full flood conditions as a result of the accident. A small portion of the earthwork, which was done after 1st August in filling the breach, was also still there and had not been washed away and was found partly consolidated.

(c) The original embankment had not given way when the water rose even to rail level but had only succumbed when the cascading started and water rose to a height of 3′ above the rails and this was obviously due to the holding power of the consolidated embankment with vegetation on its slopes. It is computed that at the time of the breach the discharge was about 7,000 to 8,000 cusecs.

(d) The breaches were filled up with ashes and moorum soil and two wagons of stones approximately 250 cft. were also thrown in. During the monsoon period, rakes of ashes and boulders are kept at convenient places for quickly restoring traffic in case of any scour, slips or breach. Scours are filled with stones, breaches in strong current are also initially filled with stones but slips and breaches where there is little or no flowing water are filled with ashes. This is the standard practice throughout India as far as I am aware. The reason for using ashes and not earth is that during floods earth may not be available within reasonable distances where ashes are available at every Loco Shed and watering stations and further earth is difficult to procure during monsoon and floods, and wet soil difficult to load and unload and carry, whereas ashes can be handled at all weather. In my opinion, a small quantity of stones, which was thrown in the embankment itself after utilising some of it in the foundation of the cribs, would make no differences whatsoever to the stability of the bank, as unconsolidated ashes have enough voids to allow slight seapage whether the stones were there or not. No stone pitching on the side slopes is done at this stage, as the stones are likely to sink in the ash slopes creating more complications later.

(e) *Width of the banks.*—The Railway embankment for M.G. line has a top width of 16′ and allowing for a 1 : 1½ slope as is adopted at this site, the bottom width will be 64′ for a 16′-0″ high bank. If consolidated, it would easily stand its own height of water and would only give way with a high cascade and even then if the flow is sustained for an

appreciable length of time. In fact on 1st August 1956, the bank stood up, even though the flood water had gone over the rails and only succumbed when water was 3' higher than rail level.

But an ash bank which had only received tamping from a few trains through its 6' long sleepers would take a long time to consolidate and its side slopes will take much longer time to consolidate and thus the bank may allow seapage under small afflux or may slip and scour by currents with 4 or 5 feet velocity and will be completely destroyed if flood water rises above cess level. Mr. Venkata Krishnan, Chief Engineer, Andhra, also is of this opinion.

(f) I have examined the Railway Bridge Registers from 1937—1956 and Section Registers from 1919—1936. It is clear from these registers that the Bridge structure of Bridge No. 229 or its flooring or approaches have never during the last 40 years of their existence required any repairs, except occasional pointing of masonry. Even after the breach on 1st August 1956, the flooring was found intact, only some copings and a portion of return wall had suffered minor damage. Thus the Divisional Engineer had correctly classified this bridge as having no "past history".

(g) The Bridge was designed on the basis of Dickens' formula which at that time was extensively used in these parts of the country, and its capacity on the basis of 4·78 sq. miles of catchment area, taking 800 at the co-efficient in 2,587 cusecs. Almost the same value has been taken by the State Irrigation Department for the design of the overflow of the weir of the Pochani Kunta tank when restored in 1953, as stated by Mr. Hardikar, Chief Engineer, Irrigation, Hyderabad. The capacity of bridge No. 229 at different levels of upstream water is tabulated below:—

C.A.=4.78 sq. miles.

Run off: 70 per cent.

Level of flood water upstream of bridge from bed level	Discharge upto level in col. 1	Intensity of rainfall necessary for the flood in col. 1	Note
12·40'	2500 cusecs.	1.18"/hr.	This is designed discharge.
14·75'	3000	1·4"/hr.	Bottom of girder.
15·75'	3200	1·5"/hr.	Cess level.
17·25'	3400	1.6"/hr.	Rail level.

(h) The average annual rainfall for 40 years from 1900 to 1940 recorded at Mahbubnagar Provincial Rain Gauge Station (as reported in the Memoires of the Meteorological Department, Volume XXBII Part B) was 30·94 and the average number of rainy days per year was 51·1 days. The highest annual rainfall during from 1941 to 1956 is 45·87 in 1955 and

the lowest 29·8 in the year 1948 and the highest daily rainfall during 24 hours was 5·37 (Observatory 5·41) in 1955. Average yearly rainfall during 1946—55 was 37 inches.

The records of this station show that during the last 15 years (1941—56) the maximum rainfall over 3" during 24 hours occurred on 14 occasions only.

2. During the first week of August 1956 when the Divisional Engineer submitted his report on the breach to the Chief Engineer, he had the following facts before him:—

(i) That no damage of any kind has been recorded in the bridge registers for the bridge or its approaches nor any high flood noted during its 40 years existence.

(ii) The Pochani Tank had been out of use upto monsoon of 1953 and therefore was ineffective and this bridge No. 229 had taken care of all flood water upto then, without even a scratch.

(iii) The P.W.D. had restored Pochani Tank and brought it into use for the first time in 1953 and this bridge had taken care of the surplus water which flowed over the weir even during the heavy rainfall of 1955, without any trouble.

(iv) With the breach of the tank, the position of the bridge had reverted to pre-1953 conditions. He, therefore, decided that as this bridge had no "past history" and was now not "tank affected", no remedial measures in regard to this bridge were required and reported to the Chief Engineer accordingly. The Dy. Chief Engineer and Chief Engineer on receiving this report did not pursue the matter any further.

3. The one factor, which the Divisional Engineer did *not* think of, was whether his newly made ash bank would stand the flood of the river on a gradient of 1 in 100, if out of the maximum 5½" of rain during 24 hours that may fall in this area, a portion say 1½ or even 1 came down in one hour or so. And here he may have been comforted by the record of highest flood level marked on the bridge and recorded in bridge book as 2'-11", overlooking the fact that this record must obviously be wrong, as it would only account for 500 cusecs of discharge, a fraction of what may come with any concentration of rain over 1/5" per hour and forgetting that he had roughly surveyed the catchment area and a flood discharge of 2,250 cusecs might be coming down through the Nullah during the normal monsoon when the water would rise to about 12'-0" above floor level at bridge No. 229.

Nor did he think that the newly made ash bank would require constant nursing and close vigilance.

4. The rainfall for 24 hours ending 8 A.M. of 1st September 1956 recorded at Mahbubnagar was 2·71 at 8 A.M. on 2nd September 1·60. Previous to this, there was not even 1/2" of rainfall on any day from 2nd August to 31st August excepting that on 27th August there was a rainfall of 1·19. There is, however, no doubt that rain fell intensively and continuously for an hour or so on the night of 1st September 1956 in the catchment area of Pochani Nallah which

brought down enough water to raise the water level on the upstream side of bridge No. 229 at least to the cess level and possibly upto or just above rail level and which later caused the P.W.D. road about 1,600 ft. downstream from bridge No. 229 to overflow for a height of 2·36 (as personally ascertained by Mr. Hardikar, Chief Engineer, Irrigation Department, on 2nd September). This is also further corroborated by the fact that on that night and during the same hours intensive rain fell over the hills next to the hilly catchment of Pochani Nalla causing the Railway embankment 8 to 9 ft. high at mile 68/9-12 to breach, over a length of 595'. Here too, the bank stood the attack from rains which fell on the nearby hill for more than a decade and the only damage recorded for this area was a long breach in 1927 and a breach of 30' in 1952 and a few scours in 1933. In fact at the time when the Express train crashed at Bridge No. 229, the patrolmen had been busy showing red lights on both sides of the breaches at M. 68/9-12 and P.W.I. himself was called out at 1.5 A.M. and was actually inspecting this breach between 1.30 and 2.30 A.M.

5. Assuming, therefore, that there was a concentrated rainfall in the catchment of Pochani Nalla of 2" between 11 P.M. and 12 P.M. on 1st September 1956, the discharge at the bridge would be at least 4,000 cusecs (with a run off 70%) and this means that water level on the upstream side of the bridge may have risen to a little over rail level at its peak and this would undoubtedly cause a breach in unconsolidated approaches of the bridge.

6. I am, therefore, of the opinion that the cause of the breach at Bridge No. 229 on the night of 1st September 1956 was the intensive but abnormal local rain during an hour or so coming down the nulla and striking the unconsolidated newly made up gaps in the Railway embankment. It is true that if the ventway had been wider, even this excessive and abnormal flood might not have seriously damaged the new embankment. But in view of the fact that for 40 years this bridge had never suffered any damage of even a small slip or a scour and had adequately met all flood conditions, it cannot be said that the Divisional Engineer was at that time absolutely wrong when he reported to the Chief Engineer early in August that no permanent remedial measures were necessary. His ground was that since the breach on the 1st August was caused by extraordinary circumstances, *viz.*, breaching of tank bund releasing over 13 million cft. of water and since for 40 years the bridge had given no trouble whatsoever, it was fair on his part to assume at that time that the ventway with a consolidated bank on either side was enough to carry normal flooding. However, as the approaches had been damaged on 1st August 1956 and there is this experience of a cloud burst in this area causing concentrated heavy rainfall for an hour or more, the ventway would naturally have to be widened.

7. The cause of the accident, however, was that the train was allowed to run down the breach in the Railway embankment and there was no one at the site of the breach to stop the train. It is almost certain that if there was a watchman at the Secunderabad end of Bridge No. 229 when the water had risen above the pre-determined level for this bridge as marked on the abutment, he

would have acted promptly and averted this disaster. It would not be out of place to point out that during the years 1955 and 1956, out of 105 and 114 cases of breaches and interruptions on the whole of Central Railway, trains were actually stopped by watchmen before they came to the spot on 31 and 29 occasions on Secunderabad Division alone.

8. It may be argued as to why public should be made to risk their lives on the action or non-action of a mere patrolman and why should not the Railways have their waterways wide enough to take care of flood water that may come from any catchment area.

Regarding the first point, I would say in working our Railways, the possibility of a disaster due to commissions or omissions of a single humble employee will always remain, so long as we do not have complete and reliable automatic control for movement of all trains and so long our embankments and bridges have to contend with excessive unforeseen concentrated rainfall and floods. There are at least a dozen Engineers' formulae on discharges from catchment basins, such as Dickens, Ryves, Beale, Craig, Chamier, Rhind, Talbot, Inglis and Ali Newaj, Khosla Hearn, Lillie and others, all based on experience and on a number of assumptions. If the assumptions made in each case do not fully meet the conditions of any particular basin, the results may be quite inaccurate. Even if a catchment is properly surveyed and measured, the run off will depend on physical conditions, vegetation, nature of soil and many other factors and above all some assumptions will have to be made for the nature, extent and intensity of rainfall. Upto now for Southern India, nobody has found serious fault with Dickens' formula being applied with coefficient dependent on the average rainfall of the year and yet we know that in this particular instance the discharge was considerably higher than could be obtained from this formula and he would be a bold Engineer indeed who would be able to guarantee 100% security against all floods and their effect on Railway banks and waterways and yet design his works on rational and economical basis. His today's assumption of 3" intensity of rainfall may be falsified by a 4" fall next year. Similarly for other formulae.

A note as to how Dickens' formula was evolved is enclosed.

This is not meant to say that the Railways should do nothing and trust on God, but it does mean that our standard of vigilance and watchfulness must be more intense and more practical, and there is also a strong case for the study of the behaviour of waterway and embankment and progressively adopt such remedies as experience dictates and are practicable.

9. The Railway Board and Railway Administrations have, since Jangaon accident and even before that, taken up this matter very seriously and have issued clear instructions. So far as the Central Railway is concerned, it is obvious that the Chief Engineer had applied his mind fully in this regard and has issued repeated instructions by circulars much more than could be ordinarily expected. This Chief Engineer has to look after about 6,000 route miles of track (8,200 track miles) with 15,000 bridges. Before he

received the Railway Board's circular, dated 2nd December 1954 on the inspection of bridges and the precautions to be taken, the Chief Engineer had issued his circular, dated 13th November 1954 (modified in certain respects on 10th May 1955). This circular with the heading "Damage to formation and bridges during monsoons" contains 6 Sections for action to be taken by the Divisional Engineers and other staff under different conditions, *viz.*,

(1) Flood damage during the monsoon of 1954;
(2) Flood damage caused in previous years;
(3) Bridge inspections;
(4) Flood heights and soundings;
(5) Railway affecting tanks and canals; and
(6) Pre-determined flood levels.

His second circular, dated 2nd December 1954 gave further instructions regarding "Inspection of bridges and Protective works" in continuation of his circular of 13th November, 1954. When he received Railway Board's circular of 2nd December 1954 to all Railways on the subject of "Inspection of Bridges", he circulated this to all concerned. He also contacted the Chief Engineer, Irrigation, and after discussion with him, prepared a draft joint circular on the subject of "Railway affecting Tanks" and issued it to his Divisional Engineers. On 18th of April, 1955, he issued a circular on "Patrolling of lines during Monsoon months", giving details of the manner in which patrolling should be done during monsoons and finally issued his circular, dated 6th of July, 1956, headed "Bridge Rebuilding", pointing out that a case had been reported where the earth filling behind abutment of a newly built bridge had sunk during heavy rains and it was, therefore, considered necessary as a precautionary measure to post watchman by day and by night to keep a very close watch on the *behaviour* of such bridges and approaches and ordered for the posting of watchmen at once. In all these circulars stress has been laid on careful examinations of conditions of bridges and embankments, calling for proposals on remedial measures and asking for special watch being kept, so long as the remedies required could not be fully met. While exhorting his Engineers to employ special watchmen during day as well as night and even asking for two watchmen by day and two watchmen by night in case of very long bridges, the only case where he has permitted grouping of adjacent bridges was in respect of railway affecting tanks situated near each other. Para. 5(b) of his amended circular, dated 10th May 1955 specifies that in case of tank affected bridges and canals it was necessary to keep a special watch during the rains and this should be done by employing one watchman by day and one watchman by night at such locations. In para. 5(c) of the same circular he says that "on certain divisions, especially on the N. S. Railway sector, there are a large number of railway affecting tanks situated near each other. *In such cases*, the number of watchmen to be employed can be reduced by grouping adjacent bridges within a distance, say, one mile". Further, whereas watching of line under other items of this circular had to take effect right from the beginning of monsoon, in the case of railway affecting tanks these watchmen are to be employed only after the tanks had

got filled to their top water level. The Dy. Chief Engineer (South) had also issued a special letter, dated 17th December, 1954, to Divisional Engineer, Poona, and the 3 Divisional Engineers at Secunderabad, referring to the Railway Board's circular and the Chief Engineer's circulars and asking the Divisional Engineers for a speedy examination of all bridges which have a past history, irrespective of whether they are important, unimportant, minor or major, explaining that bridges with past history should include those which have experienced washaways, abnormal floods, heavy afflux and breaching of approaches. In para. 6 of this letter, he again refers to Chief Engineer's circular of 13th November 1954, and referring to the precautionary measures mentioned therein when flood waters rose above pre-determined flood levels, said "You must ensure that adequate vigilance over troublesome bridges and formations is kept during the monsoons in future with a view to preventing accidents at all costs."

10. Reading these circulars more carefully, I feel that employment of watchmen for a group of bridges within a distance of a mile was limited to certain divisions only and more specially on the ex-N. S. Railway sector, where there was a large number of railway affecting tanks situated near each other. For no other purposes or conditions, grouping has been mentioned and I cannot imagine the object of the Chief Engineer issuing his circular of 6th of July if it did not mean an exclusive watchman to be kept on tracks with a new fill, so that he can keep a very close watch on the *behaviour* of such approaches. It is clearly apparent that the Chief Engineer's mind has been working continuously on the matter of safety measures on weak spots in his track and it is quite possible that when we questioned him about grouping of bridges to be watched, he was all the time thinking of the tank affecting portion of his circulars and not where other conditions came in the picture. It is also obvious from the various circulars issued by him that he had taken up in right earnest investigations and remedial measures in respect of all bridges, but naturally realising that he would have to do this on a basis of priority, he started his programme with bridges "with past history". But this would take time, because even if he was able to get all datas collected, plans decided on, estimates prepared and sanctioned in a short time, of which I have much doubt, traffic will be seriously dislocated, if attempts are made to work through a programme irrespective of priority. It is perhaps due to his appreciation of this fact, that he asked the Divisional Engineers to keep strict watch on all suspected locations and said in his evidence on 3rd January 1957 that *exclusive* watchmen had been actually posted during the 1956 monsoons on as many as 157 bridges on the ex-N. S. Railway sector.

11. The Divisional Engineer, Mr. Yasin Ali Khan's argument for not posting an exclusive watchman for the newly made up approach fills is difficult to follow. The facts are according to his evidence that:—

(i) After 1st August 1956 Bridge No. 229 was not a tank affecting bridge.

(ii) Within a week after 2nd August 1956, when he had roughly checked the catchment area, he was aware that a discharge

of 2,250 cusecs could be expected normally through the bridge No. 229 and further that the maximum flood level of 2'-11" on the bridge would only take 500 cusecs and also that the normal discharge will bring the level of water to about 12' above the bed level.

(iii) That he had two breaches 16" deep on either side of the bridge for lengths of 25' and 31' filled with ash and moorum soil.

(iv) That apart from the fact that August and September are the worst monsoon months and any continuous rain might result in settlement of these deep fills, he had a heavy-rain-fall-warning message delivered to him on the night of the 31st of August.

(v) That "history" was created for this bridge on the 1st of August, 1956.

(vi) That there is a good deal of difference between a tank affected bridge and a newly made up approach. The former was meant as an insurance against something that may or may not happen, but the latter is to protect something which has positively weakened the track.

12. Mr. Yasin Ali Khan, however, told us:—

(a) That he did understand the circular of 6th July as applicable to the restoration work done, but as he had a watchman for this bridge before 1st August 1956 as a tank affected one and the same watchman continued to remain there, he thought it was not necessary for him to report to the Chief Engineer of the appointment of a watchman, as required in the circular.

(b) He had no doubt that the Chief Engineer emphasised and reiterated the need for a very close watch on the newly made approaches and wanted a watchman by day and by night to be employed, but he did not think that this was meant to convey that he should employ an exclusive watchman, as the words "watchman by day and by night" and "close watch" mentioned in Chief Engineer's letter dated 6th of July were similar to the instructions for watches on bridges affected by tanks and those with a past history where "vigilance" and "special watch" are to be kept.

(c) That the bridge was as safe as any other bridge not having a past history, except for the fact that there was a possibility of sinkage of approaches, for which a watch was considered necessary, but there was no apprehension of approaches being washed away, except under unprecedented cloud burst. Further, he was aware that track sinkage would not be so sudden as to cause any immediate danger specially after the bank had trains running over it for some weeks, and.

(d) Then he goes on saying that considering the extent of danger apprehended to the bridge approaches under normal

monsoon conditions, the posting of a stationary watchman in this instance was neither considered necessary by him nor was it the intention of the Chief Engineer. He, however, admits that he gives all directions and sanctions in regard to employment and posting of watchmen.

13. I have no doubt that it was the responsibility of the Divisional Engineer and also of the Asstt. Engineer to see and take effective steps that these deep breaches filled up during monsoon are closely watched, not only during the height of the monsoon, but for a considerable time after that; and it should not require any instruction from anybody else. In any case, if they had any doubts as to whether this was the right thing to do or not, they should have taken the steps and then asked for clarification of the circular and should not have waited till after the accident, when, only, he said, he had a talk with the Chief Engineer. The Chief Engineer, who is in charge of over 8,000 miles of track, cannot be expected to issue detailed instructions on every conceivable difficulties and his instructions can only be in general terms, but the foremost duty of a Divisional Engineer or an Assistant Engineer is to see that the track under his charge over which trains have to run are absolutely safe for the speed allowed, and in cases where there is a possibility or even a probability of sudden deterioration, adequate and continued watch is kept.

14. I am, therefore, surprised that neither the Assistant Engineer nor the Divisional Engineer took much interest on this danger spot since the breaches were filled in on 2nd August 1956. The Assistant Engineer had trollied over this section of line once on 30th August 1956, though he travelled over it by train on five other days. The Divisional Engineer had never trollied over the section between 2nd August and 2nd September and had passed this section by train only once. It was also entirely left to the P.W.I. to increase and reduce the speed restrictions and take other precautionary and safety measures including the working of patrolmen and watchmen and apparently he received no guidance from his bosses during this period.

15. I am, therefore, constrained to say that although the track in Secunderabad-Mahbubnagar section was found by me to be in a good condition, the supervision exercised and inspection carried out by the Assistant Engineer and the Divisional Engineer were, in my opinion, unsatisfactory.

16. In the Chief Engineer's circulars there are many lacunae in the instructions issued by him, the chief of which is the grouping of watchmen in tank affected areas, their equipment, disposition, protection and supervision. But I feel that after this experience, these will be duly remedied.

The Railway Board have already issued instructions to study the behaviour and conditions of all bridges. They have also appointed a special committee to inspect the bridges on the ex-N. S. Railway and to suggest remedial measures. It is, however, common knowledge that there has been, during the last few years, a trend of changes in weather conditions, such as temperature, humidity, etc.,

all over India and it seems to me that it is high time that the Government of India, through the Council for Scientific and Industrial Research, take up investigation on the weather conditions and their effect on rainfall in every part of the country. This investigation should be made by a team of scientists, meteorologists, forest officials, Railway and Hydraulic Engineers and their report should be of great value not only to Railways but to other Departments of Government, *viz.*, Public Works, Power and Agricultural Departments.

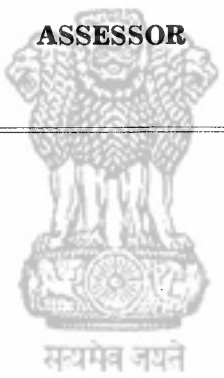
(Sd.) N. K. MITRA.

BOMBAY;
5th January, 1957.

OPINION OF

DR. K. L. RAO,

ASSESSOR



OPINION

ACCIDENT TO THE PASSENGER TRAIN AT BRIDGE 229 (JADCHERLA-MAHBUBNAGAR SECTION)

1. Introduction: Bridge, Nalla and Catchment

Bridge 229 between Jadcherla-Mahbubnagar Section is across Pochani Nalla. The catchment area of the stream upto bridge site is 4·78 sq. miles and is well wooded. There are very few people living in the catchment. The gradient of the Nalla is steep, being about 1 in 100 near the Bridge site. The railway line was constructed in 1916.

A cross section of the bridge as also plan as constructed is shown in Fig. The salient features to be noted are as follows:—

(1) Ventway provided in the Bridge is 18 ft. wide at the floor level and 20 ft. at bottom of girder and the depth to the bottom of the girder from floor level is 14·76 ft.

(2) Sloping wings are provided upstream and downstream with a splay so that the width of the floor at the returns is 32 ft.

There is a tank in the catchment intercepting 4 sq. miles. Due to a breach, the tank was in an abandoned condition for a very long time. In 1951, it was taken up for repairs which were carried through till June 1953. The tank is intended to irrigate about 230 acres and has a capacity of 13 million cubic ft. at its present full tank level of 1847. As built and repaired in 1953, the F.T.L. was 3′-0″ higher and capacity was about 17 million cft. Further details of the tank as supplied by the Chief Engineer, Irrigation, Hyderabad, are given in table I.

2. Maximum Flood Discharge of Nalla

In the railway culvert, the highest flood level (HFL) has been marked as 2′-11″ above the floor level corresponding to a maximum discharge of 400 to 500 cusecs. The maximum Flood discharge must be evidently much more than 500 cusecs. An attempt has been made to evaluate this figure.

2.1. For a big country like India with its greatly differing climatic conditions, it is not possible to have a uniform set of rules for calculating maximum discharges of rivers and streams. A systematic hydrographic survey from which a set of formula based on actual and correct evaluation of the discharges can be framed applicable to each region, has not been made. In the absence of this, calculations can be based only on the most commonly used formula in any particular region modified by any actual observations.

2.2. In the case of Pochani Nalla, we have to deal with a region just at the border of Deccan Plateau. Most generally, envelope

curves and formula such as Khosla's and Kanwar Sain's are used for Northern Rivers; Inglis for Deccan Plateau and Ryves and Dicken's in South India. In Hyderabad State, Ali Nawaz Jung's formula was adopted specially for all big streams. The practice varied again in any individual State. Thus in Hyderabad State, for roads and culverts Dicken's formula was used, while for restoration schemes of tanks irrigating less than 500 acres, Ryves was in vogue. (See the enclosed detailed letter of the C.E., Hyderabad, to C.I.R. Enclosure I.) The various formulas applicable for the region are as follows:—

Ryves

(1) Maximum discharge (D) $= CM^{\frac{2}{3}}$

(2) Dicken's $D = CM^{\frac{3}{4}}$

(3) Ali Nawaz Jung $D = CM^{0.92-1/14 \log M}$.

(4) Inglis $D = C \frac{M}{\sqrt{M+4}}$

In the above formulas C varies widely with different conditions. For the same value of C Ryves gives the least and Ali Nawaz's largest. Inglis uses only 2 values either C = 4000 or C = 7000 and gives values more akin to Ali Nawaz Jung's. The following gives the calculated values:—

S. No.	Coefficient C	Discharges: Ryves $CM^{\frac{2}{3}}$	Dicken's $CM^{\frac{3}{4}}$	Ali Nawaz Jung $M^{0.92-1/14 \log M}$	Inglis $\frac{C\,A}{\sqrt{A+4}}$	Remarks
		Cusecs.				
1.	500	1419	1617	..	..	The catchment area is 4·78 sq. miles.
2.	600	1703	1940	2343	..	
3.	700	1987	2263	2733	..	
4.	800	2271	2587	3124	..	
5.	900	2555	2910	3514	..	
6.	1000	2839	3233	3904	..	
7.	1250	3548	4042	4881	..	
8.	1500	4258	4851	5857	..	
9.	1750	4967	5658	6832	..	
10.	2000	5678	6446	7808	..	
11.	2500	7096	8083	9761	..	
12.	3000	..	..	11712	..	
13.	3500	..	..	..	..	
14.	4000	..	..	..	6456	
15.	7000	..	..	..	10491	

Problem remains as to what value should be adopted for Pochani Nalla. If Ryves formula with C=850, generally adopted for hilly country such as Pochani, is taken, the calculated maximum discharge will be 2,413 cusecs; using Dicken's and a coefficient of 1,000, the value will be 3,233 cusecs and Ali Nawaz Jung gives 3,904 cusecs. Inglis with smaller coefficient of 4,000 gives 6,456 cusecs.

Mr. Hardikar (Chief Engineer, Andhra Pradesh), stated that he would recommend applying Dicken's formula in calculating the maximum discharge of the Nalla for designing Railway culverts. He stated that the coefficient should be high. Assuming a value of 1,000, the maximum discharge would be 3,233 cusecs.

In the present case, as the catchment area is hilly with a forest cover and steep gradient, the maximum can be taken as 4,000 cusecs. 6,500 cusecs will be an outside figure. An engineer to justify his role has to aim at economy consistent with safety and the value chosen would depend on the risks that can be taken with each particular structure. Thus if a masonry dam is being designed with a spill, I would have taken only 4,000 cusecs.

As no risks should ordinarily be taken with railway culverts, a higher figure may have to be used. A rational and economical method would be to design to culvert for a discharge of 4,000 cusecs without appreciable afflux and ensure that a flood of 6,500 cusecs would still pass on without endangering the structure, though with a high afflux.

2.3. The formulas discussed above are based on statistical analysis. A simpler approach often sought for is to determine the discharges based on rainfall records. Actually this is the correct approach as stated above in para. 2.1. Simultaneously with measurement of rainfall, the river flows also should be measured for different intensities of rainfall and then a table should be constructed from which the probable discharge corresponding to any definite rainfall can be read off. In the absence of this, a number of assumptions have to be made, such as factor of run off, the characteristics of the rainfall (known as hydrograph), the condition of the ground as to its saturation at the time of rainfall etc. Nevertheless an idea can be obtained considering the rainfall data.

In the case of Pochani Nalla, the maximum discharge, under prior saturated conditions, and assuming 75 per cent. run off, will be approximately 2,000 cusecs per inch of rainfall per hour. If we assume the probable intensity of rainfall as 2 inches per hour, the maximum discharge would be 4,000 cusecs, a figure which tallies from the value obtained by using formula in para. 2.1.

3. Breaches and discharges in August and September, 1956 at Bridge 229.

3.1. *Rainfall.*—There were two breaches at the Bridge site, the first being on the 1st August, 1956, near midday and the second being near midnight on 1st-2nd night of September 1956. In the last fortnight of July there was a heavy rainfall in Mahbubnagar area. On 30th July ending with 8 A.M. a rainfall of 4·11 inches was recorded. On 1st August it was 1·25 inches. After that the rainfall was reduced but continued to some extent or other for eighteen days in the month. On 1st September and 2nd September the rainfall recorded

was 2·71 inches and 1·60 inches. The significant rainfalls to be noted immediately preceding the breaches are 1·25 inches for a day ending with 8 A.M. on 1st August and 1·60 inches per day ending with 8 A.M. on 2nd September.

3.2. There are no measured discharges on either occasion. To deduce the discharges, the only reliable field data we have is as follows:—

(i) The road bridge downstream has been overtopped by 2·86 ft. on the first occasion, and 2·36 ft. on the second.

(ii) The rail track was overtopped by nearly 2·94 ft. on the first occasion.

Reliable calculations cannot be made on the basis of the above data alone. Overtopping of the roadway can be caused by the greatly restricted waterways in the road bridge on the same Nalla. Approximate calculations utilising the data and making some assumptions, would yield the peak discharge on the first occasion as 7,000 to 8,900 cusecs and on the second occasion varynig between 4,000 cusecs to 6,000 cusecs. While considerable length of ballast was washed away on the first occasion, there is no evidence to show that ballast was washed away from the track lying adjacent to the breached sections. To cause movement of the ballast, a velocity of 4 ft. to 6 ft. would be required and this would mean appreciable overtopping of the rail line as on the first occasion. The driver's account that the water came upto his neck shows the probability of the water level being just above the cess level. This is further corroborated by other witnesses who said that the water level on the cess was only about ankle deep. A maximum discharge of 4,000 cusecs would itself mean 6″ to foot above the rail level. Thus it can be concluded that the maximum discharge on the first occasion was in the order of 7,000 cusecs and on the second occasion in the order of 4,000 cusecs.

4. Accident

The breach in August was undoubtedly due to the breach in Tank and sudden rush of water. The tank was stated to be full upto FTL due to the rainfall in month of July 1956. On 1st August there was again a rainfall the value of which as recorded at Mahbubnagar is 1·25 inches. It is quite likely that the weir was overflowing appreciably. During inspection of the surplus weir of the tank, I found the downstream apron completely scoured. When the tank had burst, waters in excess of 13 million CFT was released and reach the railway line and overflowed it, resulting in breaches on either side of the bridge. The enclosed figure shows the breached portions. These were subsequently repaired by the Railway authorities. On 1st/2nd September night, there was a heavy rainfall between 10.30 P.M. to 12 P.M. resulting in a large flood. The flood waters could not readily go through the bridge and caused a high afflux. The water level rose certainly to cess level and possibly few inches over the rail level. The banks were breached and as there was no warning the passenger train came on the bridge according to scheduled timings, that is a few minutes after midnight. The accident occurred resulting in smashing three coaches with attendant loss of human lives. The engine, however, went over the bridge span and was found in a standing position with its front end at the ground level on Mahbubnagar side. The driver and fireman did not receive any

major injuries and were not even thrown out. The only feeling expressed was that it looked to them that they were going up and the engine was going down. The fall had taken only a fraction of minute. It appears from the above that the engine got derailed and there being no solid ground underneath, shot out as a projectile with a velocity of 25 to 30 miles an hour. During its descent, it destroyed the ballast wall of Jadcherla abutment, threw out the girders and hopped on the Mahbubnagar abutment, with its centre of gravity well on the Mahbubnagar side of the abutment. Thereafter it ploughed its way against earth and water, which offered gradual resistance and with no shock.

5. **Causes of Accident**

Speaking generally the cause of the accident is undoubtedly the occurrence of breaches on both sides of culvert 229 and absence of warning to the driver. Strangely the driver and the firemen stated that they did not know even about the breach that occurred a month earlier so that they could have been more cautious.

I shall deal only with the aspect pertaining to the occurrence of the breaches. As shown in the earlier paragraph, the water in the Nalla at the time of the accident is about 4,000 cusecs. The bridge ventway is greatly insufficient to carry this water. The principal cause of the accident in my considered opinion was the heavy concentrated rainfall of about 2" per hour or over in the catchment area and insufficient ventway. The railway engineers incharge were regretfully lulled into a false sense of security by the HFL marked in the ventway. The HFL mark is absurdly low; as it would mean only a discharge of 500 cusecs. The railway engineers were not aware of the catchment area of the Nalla nor its characteristics. The occurrence of breach on 1st August, if analysed would have shown the inadequacy of the ventway. The second unfortunate mistake done after 1st August was to assume that complete safety was restored due to the bursting of the tank. Actually the tank, in a good condition, would have been helpful in moderating the floods even though it may not be to any appreciable extent. The bursting of the tank has not added to the safety but rather to the dangers due to great floods. I am of the opinion that the railway engineers incharge prior to the accident have not studied the hydrology of the Nalla and therefore did not realise the utter inadequacy of the ventway in culvert No. 229. This is regretable specially after the sad Jangaon accident and after the breaches in the same culvert a month earlier.

The bridge ventway must be immediately enlarged to deal with discharges as discussed in the earlier paras.

I would like to add that the breaches in the banks had been accelerated by the unconsolidated and unprotected condition of the banks. Substantially the same lengths of banks as were constructed after 1st August, were breached. The coal ash and earth slopes were not protected with stone except for the portions upto erroneously marked HFLS. The banks were subjected to velocities of 10 ft. per second and more so that the banks must have slipped and hastened the breach. I am told that the usual procedures were followed in making the banks. While I hold that even the procedures must be modified to be consistent with modern practices, there is no justification for omitting stone protection of the slopes except under the condition that the water will never rise 3 ft. above floor level. There

is, however, an implied admission that the banks will be subjected to high water levels upto at least predetermined levels which are arbitrarily fixed as one foot below the bottom of the girder. The banks specially being new, must have been protected with stone pitching next to the sloping wing walls upstream upto the predetermined levels.

6. Recommendations

I have a few recommendations to make to ensure that accidents of the type do not occur in N. S. Railway:—

(i) The hydrology of all streams in N. S. Railways must be studied with the available data. Fortunately P.W.D., Hyderabad, maintains records of all tanks with irrigation of more than 10 acres. The ventways of all the bridges must be checked for the maximum discharges that would be obtained using Dicken's with a coefficient of 1,000. Where inadequacy is seen from the calculations, watchmen must be employed on each such individual bridges till further calculations prove otherwise or till ventway is improved. It is implied that even in cases where ventway is not enlarged, full protective pitching is built for the full height conditions that would be obtained for the calculated discharges.

(ii) Reasonable facilities must be given to watchmen and patrolmen by way of providing shelters and rain coats or equivalents.

(iii) It is necessary to ensure that to the exclusion of even attending meetings and other duties, a Divisional Engineer must concentrate and inspect personally important breach works before full speed is resumed.

(iv) Just as vigilance is kept regarding structural safety of the bridges, the hydrology of the rivers must be watched irrespective of the studies made by the other departments. For this a hydrology section with adequate staff must be opened in each zone.

The 3rd January, 1957.

(Sd.) K. L. RAO.

TABLE I

Particulars of Pochani Tank

F. T. L.	1850·00
M. W. L.	1854·00
T. R. L.	1855·00
T. B. L.	1859·00
Top width of Bund	8′
Front slope	(*a*) Revetted 1½ : 1
	(*b*) Non-revetted 2 : 1
Rear slope	(*a*) 2 : 1
	(*b*) 4 : 1
Catchment area	4 sq. miles free.
Yield	57·45 Mcft.
Capacity of the FTL	17·28 Mcft.
Sill level of sluice	1823·00
Max. Flood Discharge	2520 cusecs.

ENCLOSURE I

Copy of letter No. 332/P-I, dated 16th December 1954, from the Chief Engineer, Irrigation, Hyderabad, to the Government Inspector of Railways, Central Railways, Secunderabad, Deccan.

Reference: Your letter No. N/54/25, dated 16th December, 1954.

The following procedure is being adopted for computation of maximum flood discharge in designing the surplus arrangements for irrigation works:—

(1) For tanks whose irrigation is below 500 acres or roughly 20 to 25 sq. miles of catchment area. As per extract attached.

(2) For tanks whose irrigation is from 500 acres to 2,000 acres or between 25 and 100 sq. miles of catchment area. Dicken's Formula with co-efficient of 800 with no allowance for interception.

(3) For tanks whose catchment area is above 100 sq. miles upto 250 sq. miles....Dicken's Formula 1,000 as co-efficient and no allowance for interception.

(4) For tanks whose catchment area is above 250 sq. miles. Ali Nawaz Jung's Formula as given below.

$$\frac{0 \cdot 92 - 1/14 \log M.}{1700 M.}$$

But in the case of culverts, aqueducts and other masonry works on canals, we adopt Dicken's Formula only without any deduction for interception, and with co-efficient varying between 800 to 1,500 according to the magnitude and nature of the catchment.

If records of high flood observation are available on the stream in cases 3 and 4 above, the maximum flood is computed with Kutter's Formula and the higher value when compared with the empirical formula is adopted.

(True copy)

Extract from the Public Works Manual. Maximum Flood Discharge.—The maximum discharge from the catchment area must be calculated by Major Ryve's Formula $D=CM^2/^3\ Cm^2/^3$ where D=Discharge in cusecs, M=Total catchment area in square miles, m=Intercepted area in square miles. The value of C varies with the nature of the catchment and amount of rainfall as given below C is 100.

Co-efficient in Major Ryve's Formula Calculation Discharges.

Monsoon Rainfall	Nature of Catchment			Remarks
	Good	Average	Bad	
37½ to 40″ .	900	850	800	As a general rule the marginally noted Coefficient may be adopted. In special cases, they may be suitably modified giving reasons.
35 to 37″ .	850	800	750	
32½ to 35″ .	800	750	700	
30 to 32½″ .	750	700	650	
27½ to 30″ .	725	675	625	
25 to 27½″ .	700	650	600	
22½ to 25″ .	675	625	600	
20 to 22½″ .	650	600	600	
17½ to 20″ .	625	600	600	
15 to 17½″ .	600	600	600	

REPORT

BY

SHRI C. R. SULE

GOVERNMENT INSPECTOR OF RAILWAYS, BANGALORE

ON THE

ACCIDENT TO No. 565 DOWN PASSENGER TRAIN AT BRIDGE No. 229 AT MILE 66/15-16 (OLD) 66/21-22 (NEW) BETWEEN JADCHERLA AND MAHBUBNAGAR STATIONS— SECUNDERABAD DIVISION, CENTRAL RAILWAY, ON 2nd SEPTEMBER, 1956.

SUMMARY

Date	2nd September, 1956.
Time	00-39 hours.
Railway	Central.
Location	Girder Bridge No. 229 (1-20′ Girder) Mile 66/15-16 (old) 66/21-22 (New) between Jadcherla and Mahbubnagar.
Nature of accident	Derailment at girder bridge.
Train involved	Passenger.
Train Number	565 Down Passenger.
Number of Engine	2084 Y.P. (4-6-2)
Consisting of	Nine passenger bogie coaches and one 4-wheeler parcel van.
Estimated speed	30 miles per hour.
Track	Single (3′-3⅜″)
	Left hand curve 2°
	Falling gradient 1 in 133.
Weather	Dark, cloudy and drizzling.
Casualties	Killed (known)—121
	Grievously hurt—5
	Minor injuries—16
	Trivial injuries—16
Cause	Erosion and subsidence of embankment behind the bridge abutments.

To

The Secretary to the Government of India,
Ministry of Communications,
New Delhi.

Through

The Chief Government Inspector of Railways,
Ministry of Communications,
Simla.

Sir,

In accordance with Rule 9 of Railway Board's Notification No. 1926-T dated 19th March, 1930, I have the honour to submit herewith the result of my inquiry into the accident to No. 565 Down Passenger train which occurred at mile 66/15-16 between Jadcherla and Mahbubnagar stations of the Central Railway on 2nd September, 1956.

2. I received the information regarding the accident at Madras on the 2nd September. I immediately left Madras arriving Mahbubnagar on 3rd evening and inspected the site of the accident. The site of the accident was again inspected by me on the 4th, 8th, 11th and 12th September, in company of the Chief Engineer and the Deputy Chief Engineer, Central Railway.

3. (i) The inquiry was started at Mahbubnagar on the 4th and recording of evidence concluded at Secunderabad on the 18th. The venue of the inquiry was shifted to Secunderabad from the 14th. Evidence of one witness was recorded at Secunderabad on 25th October, 1956. In all 82 witnesses were examined and their evidence recorded.

(ii) The following officials were present:—

Name	*Designation*	*Present on (dates in September, 56)*
	Central Railway	
Shri R. Hydari	Divisional Superintendent, Secunderabad.	All days except 17th.
„ N. M. Thadani	Chief Engineer, Bombay	9th and 14th.
„ F. X. Lobo	Dy. Chief Engineer (South), Bombay.	4th to 14th and 18th.
	Railway Police	
Shri Ali Akbar Khan	Superintendent of Railway Police, Secunderabad.	5th.

Name	*Designation*	*Present on (dates in September, 56)*
	Civil Officers	
Shri G. S. Srinivasan	Distt. Collector, Mahbubnagar, Dist. Mahbubnagar.	4th.
„ R. Venkatesan	Dist. Superintendent of Police, Mahbubnagar, Dist. Mahbubnagar.	4th and 6th.
„ Mohamed Abdul Aziz	Dist. Magistrate, Mahbubnagar Dist. Mahbubnagar.	4th to 12th.
„ Iqbal Ahmed Razzaqui	Dy. Superintendent of Police, Mahbubnagar, Dist. Mahbubnagar.	4th to 6th and 10th.

(iii) The catchment of the Nala was inspected on 4th September 1956. Some evidence was obtained by correspondence. The question of adequacy of water-way, bridge design, erosion of bank, subsidence, etc., was discussed in detail with the Director, Central Water & Power Research Station, Poona, on 11/10 and 27th October 1956.

(iv) The track, between Jadcherla and Mahbubnagar, and bridge No. 229 were inspected by motor trolly on the 17th September, 1956.

(v) Visibility test, under almost similar conditions, was carried out on the night of 12/13th September, 1956, by a light engine.

Description of Accident

4. No. 565 Down Passenger arrived Jadcherla at 00-22 hours and left at 00-24 hours. While running from Jadcherla to Mahbubnagar at normal speed, it crashed through bridge, No. 229 —1-20 feet girder— across a stream called Pochani Nala, 7·5/8 miles from Jadcherla. The engine came to a stop, against the formation beyond the Mahbubnagar-end abutment, in an inclined position pointing upwards. The leading trolly wheels were about 6″ above and the foot-board about 8′ below, the track level. The tender came to rest on the partially demolished abutment at the Mahbubnagar-end almost on even keel and in the original alignment. The following two coaches were completely telescoped and damaged. The third one was partially damaged. The rear portion of this coach was on the original alignment. These three coaches together with the engine and tender were found in an arrow head formation, the engine and the tender forming the point, the under-frame of first coach, TY 0221, its left arm, the underframe of second coach, GT 94, its right arm and the third coach, FCS 152, and remainder of the train, the shaft. None of the other coaches had even derailed.

Casualties

5. It is regretted that 121 persons are known to have lost their lives and 37 persons were injured. The injuries to 5 passengers were serious. Injuries to the remaining 32 were either minor or trivial.

Bodies were picked up upto a distance of about 2½ miles downstream from the bridge, *i.e.* upto and including Namdar tank into which Pochani Nala flows. The search for the bodies was pursued for about 5 days after the accident. It is not likely that any more bodies remain to be recovered, though such a possibility cannot altogether be ruled out considering the circumstances of the accident. It may be mentioned that Scale Porter, Rajiah Narasiah, was known to have been travelling by this train. He is missing but his body has not been identified if it has been recovered or has not yet been found. Out of the 121 bodies recovered, 47 still remain unidentified. Out of the 37 persons injured, two are still undergoing treatment as in-patients in Lallaguda Hospital.

Composition of the train

6. (i) The train was hauled by engine No. 2084 YP (4-6-2) followed by 9 bogie passenger coaches and one four-wheeler luggage van. The order of marshalling these coaches was as follows:—

Engine No. YP 2084 with tender No. 2115 .	Central Railway.
Third class coach No. TY0221 . . .	Do.
Third class coach No. GT94	Do.
Composite first and second No. FCS 152 .	Do.
Third class coach No. GT420 . . .	Do.
Third class coach No. T78 . . .	Do.
Third class coach No. GT423 . . .	Do.
Third class coach No. T7148 . . .	Southern Railway.
Composite first and third class coach No. FCT 169.	Central Railway.
Composite third luggage and brakevan No. TLR 7235.	Southern Railway.
Luggage van four-wheeler No. EVK 319 .	Central Railway.

(ii) The total length of the train including the engine was approximately 640 feet and its tare weight, 374·5 tons.

(iii) The train was fully vacuum braked with nominal brake power of 243·2 tons. The ratio of brake power to the weight of the train was approximately 65 per cent.

(iv) The first wrecked coach, CR TY 0221, had steel underframe built in 1917. The body work was wooden frame with interior horizontal wooden panelling and exterior steel panelling built in Lallaguda shops in 1945.

(v) The second wrecked coach, CR GT 94, was built in 1949. It had IRS steel underframe. The body was wooden frame with wooden horizontal interior panelling and exterior steel panelling.

(vi) The third damaged coach, CR FCS 152, was built in 1952. This coach had IRS steel underframe and wooden body of the standard N.S.R. pattern for upper class coaches. It consisted of wooden frame with interior panelling of plywood and exterior panelling of steel.

Number of passengers

7. (i) As far as could be ascertained, 407 passengers were booked by No. 565 Down. Out of these, 136 were booked for stations upto Jadcherla. Thus, there were 271 ticket-holding passengers on the train when it left Jadcherla. In addition, it is ascertained that 43 persons were travelling on duty or privilege passes, making a total of 314 persons known to be travelling by the train at the time of the accident.

(ii) The carrying capacity of the two third class coaches, Nos. TY 0221 and GT 94, was 81 and 75 respectively. One compartment of 32 seats was reserved for Railway Mail Service in the first coach No. TY 0221; one compartment of 8 seats was reserved for brakesman and one compartment of 8 seats for ice vendor in the second coach, No. GT 94. Accommodation available for the use of passengers was thus 108 seats. The upper class coach had accommodation for 14 second class and 12 first class passengers.

Damage

8. (i) Bridge No. 229, the bridge girders, permanent way to a length of about 120 feet, the engine, tender and first two coaches, TY 0221 and GT 94, were badly damaged. The third coach, No. FCS 152, was partially damaged. The main damages to the various items mentioned are given below:—

(ii) *Engine No. YP 2084*

Buffer beam and cattle guard badly bent; The drag box damaged. The right boiler palm-stay bent and left palm-stay bolts sheared off from the smoke box. The left connecting rod bent. The radial wheel assembly detached. The assembly was found buried in the river bed about 35 feet downstream inside the wing wall. Compensating beam between radial and trailing wheels bent. The right side wind cutter plate smashed and all its bolts sheared off. The front buffer bent upwards and to the right. The buffer plate had a deep elongated vertical score. Both the Central driving wheels—flange less—had deep score marks radially at the same place. Similar deep marks were also seen on the flanges of the trailing driving wheels as well as the hind truck. All these marks show firmly embedded particles of masonry.

(iii) *The tender*

The tender had both vacuum cylinders broken. Its front trolly had separated from the underframe and was found against the face of the Mahbubnagar-end abutment.

The left side of tender frame was slightly bend and the rear tank portion damaged.

(iv) TY 0221

About two-third of the body work of this coach was completely smashed. The remaining one-third had its right side panelling and end panelling broken.

About 15 feet length of the underframe towards the front end was bent upwards.

Both its trollies had separated from the underframe.

A portion of its roof was found about 1,800 feet downstream.

(v) *GT* 94

The body work of this coach was completely destroyed. Both the trollies, however, remained attached to the underframe.

(vi) *FCS* 152

One-third portion of the body work of this coach at the leading end was destroyed. The front 15 feet of the underframe was bent downwards.

Both the trollies of this coach remained attached to the underframe.

All the remaining coaches on the train suffered no damage and were on the rails.

(vii) *Permanent Way*

Four rail lengths of track were completely demolished. The rails were broken into pieces of varying lengths from 1'-6" upwards. One piece of rail 15'-9" long bent into the shape of a hockey stick was found under the left hand girder in front of the engine. Another piece of rail about 14'-3" long also bent in the form of a hockey stick was lying on the left of the track near the left hand girder. This rail was lying upside down with three trough sleepers still attached. The steel trough sleepers had their jaws forced open. About ten of these had light marks of derailment on them. The trough sleepers with marks of derailment were found; some on the embankment and some in the bed of the Nala on the Jadcherla side. None of the trough sleepers found near the Mahbubnagar side had any marks of derailment.

(viii) *Bridge*

The Jadcherla-end abutment and the wing walls were demolished upto about 2 feet from the bed level. The masonry below that was sound. The Mahbubnagar-end abutment was destroyed upto about 5 feet from the bed level but the down stream wing was standing almost upto the original height. This portion of the wing had cracks. The masonry in the undemolished portions of this abutment was also sound.

The flooring and drop walls of the bridge were in tact. There was no evidence of scour.

The left hand girder was found lying across the track with its leading end 28'-6" ahead of the engine. Six diaphragms connecting this to the right hand girder had been sheared. The outstanding leg of the right hand stiffener angle at the trailing end and of the left hand stiffener angle at the leading end had also been sheared.

The right hand girder suffered very extensive damage. In addition to the diaphragms being sheared, it had its top and bottom flanges badly damaged. Top side of the bottom flange and underside of the top flange showed wheel marks. The right hand end stiffener angle of the trailing end had a deep flange cut. The bearing plate at leading end was bent downwards. The whole girder had badly buckled.

All hook bolts were found to have been forced backwards and either bent or broken. All the 16 bridge sleepers were thrown out on the embankment at the Mahbubnagar end. None of the bridge sleepers showed marks of wheel flanges. Small pieces were broken off from two old bridge sleepers. Other 14 were undamaged.

There were two sleeper cribs one behind each abutment provided during the restoration of the breach, which had occurred on 1st August 1956. These cribs were made up with 107 sleepers; out of these, 86 sleepers have been recovered from the bed of the Nala. None of these sleepers show damage of any kind.

(ix) *Estimated damages*

The Railway has estimated the damage to the rolling stock including engine at Rs. 2,35,000 and that to the Permanent Way including the bridge at Rs. 30,000 approximately.

Weather conditions

9. At the time of the accident, the night was very dark being within three days of the New Moon. The sky was overcast and there was a moderate drizzle.

Relief Measures

10. (i) No. 565 Down Passenger left Jadcherla at 00.24 hours and should have arrived Mahbubnagar at 00.44 hours. As the train did not arrive till 01.05 hours, the Assistant Station Master on duty at Mahbubnagar, in consultation with the Secunderabad Control, sent a memo to the Permanent Way Inspector stationed at Mahbubnagar, to proceed by trolly and investigate. The Permanent Way Inspector left Mahbubnagar at 01-25 hours. At mile 68/12-13 he found that water was flowing over bridge No. 238. The bank at mile 68/11 had also breached and could not be crossed. He found no trace of No. 565 Down. From his previous experience he was confident that the train probably had been stopped by one of the bridge watchmen or night patrolmen on the far side. He, therefore, sent a memo through one of his men to the train driver asking him to push the train back to Jadcherla. He had instructed his man to carry the memo by the P.W.D. road. The Permanent Way Inspector returned to Mahbubnagar, to apprise the Secunderabad Control and other Railway authorities of the breach, arriving at about 02.45 hours. While he was conveying this information a passenger from No. 565 Down arrived on his bicycle bringing a memo from the guard of the train stating that the train had met with a serious accident. This memo

reached Mahbubnagar at about 02.55 hours. The Permanent Way Inspector immediately made arrangements to intimate the District Collector, the District Superintendent of Police, the Civil Surgeon, the Railway Assistant Surgeon and others. He also immediately contacted the Supervisor of the Road Transport Organisation and obtained services of three buses to reach the site of the accident. The Assistant Surgeon (Railway, Mahbubnagar), the Permanent Way Inspector, the Assistant Station Master along with other railway staff and the medical equipment left Mahbubnagar at about 03.25 hours by the Road Transport Department buses. They reached the site of the accident at about 03.45 hours. This was the first medical party to reach the site of the accident. Before this party arrived, rescue work and first aid was carried on by a few passengers and railway staff who were travelling on the train. The first aid box available in the brakevan was made use of.

(ii) The Civil Surgeon, who was intimated about the accident, arrived at the site of the accident by a private car almost on the heels of the railway relief party. He brought with him necessary medical equipment and was accompanied by his assistants. All the injured were given necessary medical attention at the site by these two medical parties. Some of the seriously injured were removed to the Mahbubnagar Government Hospital.

(iii) In the meanwhile, under instructions from Secunderabad Control, arrangements were made to rush refreshments from Mahbubnagar. Refreshments were despatched by the Road Transport Department bus from Mahbubnagar at 05.08 hours and were supplied to the passengers immediately on receipt.

(iv) The information about the accident was received by Secunderabad Control at 03.05 hours. The Control immediately made arrangements to run Medical Relief Train. The Loco Shed and the Railway Hospital were intimated about this at 03-10 hours. The Medical Relief Train left Lallaguda at 03.52 hours with the District Medical Officer, Lallaguda, two Assistant Surgeons, the Divisional Superintendent and other Divisional officers. It arrived at the site at 06.49 hours. By this time, however, all the casualties had been attended to by the Assistant Surgeon Mahbubnagar, and the Civil Surgeon, Mahbubnagar. The District Medical Officer examined all the casualties that were still at the site.

(v) The King Edward Memorial Hospital, Secunderabad, was informed about the accident at 03-45 hours. Three doctors from this hospital and some staff arrived at the site of the accident by a car at about 07-00 hours.

(vi) The Osmania General Hospital was also intimated by the Secunderabad Control at 03.50 hours. Col. Waghery with a batch of doctors and medical students arrived by car and ambulance at about 08.30 hours.

(vii) Dr. Khatri, Director of Medical Services, Hyderabad, and his staff arrived by road at about 10.30 hours.

(viii) At the request of the District Medical Officer, Lallaguda, Dr. Khatri loaned his ambulance car to transport the serious cases to

Lallaguda Railway Hospital. As the P.W.D. road was breached, the serious cases had to be taken to Jadcherla by the medical and inspection coaches. From Jadcherla they were taken by the ambulance car to Lallaguda Railway Hospital and admitted at 14.05 hours.

(ix) The General Manager, the Chief Medical Officer and other officers of the Central Railway rushed to Secunderabad by air and proceeded to the site of the accident by road reaching at about 13.45 hours. The Chief Medical Officer visited 11 patients who were admitted in the Civil Hospital at Mahbubnagar. Four of these patients, he considered, needed further investigation and treatment. As facilities at Mahbubnagar are inadequate, they were transferred by ambulance car to Lallaguda and were admitted in the Railway Hospital on the 3rd.

(x) The Deputy Superintendent of Police, who was in charge in the absence, on leave, of the District Superintendent of Police, received the intimation about the accident at about 03.10 hours. He immediately collected his men and rushed to the site of the accident. He found the Civil Surgeon and the Railway Doctor had already reached and were rendering medical aid to the injured. He immediately started rescue operations. As soon as it was light, the Collector arranged with the help of the Deputy Superintendent of Police, to comb the area for dead and injured. Arrangements were also made to secure the property of the passengers and to post guards to prevent looting.

(xi) A thorough search was made for 2½ miles downstream upto and including Namdar tank into which this stream flows. The search was continued for about five days after the accident and 121 bodies were recovered.

(xii) Immediately after the accident, arrangements were made to open an Information Office at Secunderabad and also at other important points such as Kacheguda, Kurnool Town, Hyderabad, etc., to inform the public regarding the accident.

(xiii) Arrangements were also made to send free telegrams to the friends and relations of such of the passengers who wanted their welfare to be notified.

Restoration of Communication

11. (i) Due to heavy rain on the night of 1/2nd September 1956, there was also a breach at mile 68/9-12. This, in addition to the accident to No. 565 Down, prevented through running of trains or transhipment on Secunderabad-Dronachellam section. The train service was, therefore, resumed immediately between Secunderabad and Jadcherla on one side and Mahbubnagar and Dronachellam on the other. The transport of passengers and mail between Jadcherla and Mahbubnagar was arranged by means of buses with the cooperation of the Road Transport Department.

(ii) The breach at mile 68/9-12 was closed on the evening of 4th September 1956. The removal of the wreckage and provision of temporary bridge were completed at 16.45 hours on 12th September 1956 and through running resumed at restricted speed. No. 554 Up Express was the first train to pass the site of the accident at 19.47 hours on the same day.

II. DESCRIPTION

Locality

12. (i) The general direction of the line between Secunderabad and Dronachellam is from North to South. However, the alignment takes a right angle turn at Jadcherla and the direction between Jadcherla and Mahbubnagar is from East to West. The alignment between Jadcherla and Mahbubnagar passes through a hilly broken country with patches of paddy fields interspaced. Near the alignment, there are a number of hills rising upto 300 feet above the surrounding ground level. The section of the railway over which the accident occurred is a part of Secunderabad Division, which constituted the Nizam's State Railway before its merger into the Central Railway on 5th November 1951. There is a well-maintained road connecting Mahbubnagar to Secunderabad which runs in close proximity of the railway line near the site of the accident. It crosses the railway line at mile 66/7-8. The mileages of various stations mentioned in the report are as under:—

Lallaguda	Mileage	2
Secunderabad	,,	0
Falaknuma	,,	9
Umdanagar	,,	17¼
Shadnagar	,,	36¾
Jadcherla	,,	59¼
Site of the accident	,,	66/4617 feet
Site of the breach	,,	68/2070 feet to 68/2665 feet.
Mahbubnagar	,,	70¼
Gadwal	,,	116¾
Dronachellam	,,	184½

(ii) There are 18 telegraph posts per mile. These are being replaced by 24 posts per mile but the new posts have not yet been numbered. Therefore, reference is made only to the old telegraph post numbers. The directions, 'right' and 'left' are with reference to the direction of the movement of the train. The distance by road from Secunderabad to the level crossing at mile 66/7-8 is about 55 miles.

(iii) The headquarters of the Division is at Secunderabad. The Divisional Officers and the Assistant Engineer are stationed at Secunderabad. The District Medical Officer is stationed at Lallaguda where there is a well-equipped Railway Hospital with 120 beds. An Assistant Surgeon is posted at Mahbubnagar and is in charge of the Railway Hospital with 8 beds. The Train Control Office is located at Secunderabad.

The Nala

13. (i) Pochani Nala is a hill stream having its source in an amphitheatre of hills approximately two miles to the north of the railway line. The total catchment area of this nala upto the bridge is approximately 4·37 sq. miles. The catchment area is surrounded on all sides by high hills rising upto 300 feet and is fairly thickly wooded. About 9,000 feet upstream from the bridge, the catchment has been bunded to form a tank called Pochani Kunta. The capacity of this tank is 13·16 million cft. at full supply level. At the full supply level, the tank has a free board of 12 feet. From the tank,

Pochani Nala starts as a broad stream but gradually narrows down and flows through a fairly deep winding channel upto the bridge. Just before meeting the railway line, the nala takes a right hand turn. It meets the railway embankment at a slight angle. The railway line crosses this Nala by a —1-20—girder bridge. After leaving the bridge, the nala continues as a narrow stream upto the P.W.D. road approximately 1600 feet away. At the road it is bridged by a —1-10′—arch. After crossing the road it continues its course into Namdar Cheruvu.

(ii) It is not known when the bund of Pochani Kunta was first raised. However, it is said that the bund had breached years ago and was left unrepaired for a long time. Repairs to this bund were undertaken in 1951 and were completed in 1956. Since the repairs of the bund were undertaken in 1951, there had been a partial slip of the bank in the year 1953. After the slip, the free board of the tank was increased from 9 feet to 12 feet by lowering the level of the waste weir. The slip was repaired and the tank has been functioning since then till it breached on 1st August 1956. The Chief Engineer, P.W.D., Hyderabad has advised that the breach has not been partially or fully repaired. There is no impounded water in the tank except in a few local pits. All the run off from the catchment area flows directly through the breached portion into the Pochani Nala emptying into Namdar tank. The total catchment area of Pochani Kunta is approximately 4 sq. miles. The average gradient of the bed of Pochani Nala from Pochani Kunta upto the railway bridge is 1 in 100. The banks of the Nala are generally of hard moorum and the bed is non-erodable.

Bridge No. 229 at mile 66/15-16

14. (i) According to the completion drawing, the bridge was completed on 4th September 1916 during the construction of Secunderabad-Gadwal Railway as a 20-feet girder bridge. The abutments are coursed rubble in lime masonry. The foundations are open lime concrete founds. From the completion drawing it is also seen that it is founded on moorum. The abutments have a batter of 1 in 6 in the front and stepped section at the back. Originally, the girders rested on timber bed blocks. These have been replaced by cement concrete bed blocks in 1934 and 1938.

(ii) The girders are wrought iron 'V' type, 1′-8″ deep, manufactured by Westwood Baillier Company, Engineers, London. Owing to limitation of shear stress in the rivets the speed of YP locomotives is restricted to 40 M.P.H. It is a built up girder with ½″ web plate and $4\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{5}{8}''$ angles. There are $10' \times \frac{1}{2}''$ cover plates on either sides. The girders have been secured to the concrete bed blocks on the abutments by 1″ dia. holdingdown bolts.

(iii) The bridge has been provided with coursed rubble masonry flooring and drop walls. The headway at the bridge from the floor up to the bottom of the girders is 14·33 feet. After the accident, it was noticed that there was approximately one foot of silt over the flooring.

(iv) Stone pitching has been provided beyond the returns for a length of 10′ and a height of 3′ on the upstream side at Jadcherla

end and for a length of 10′ and a height of 4′ on the downstream side at Mahbubnagar end.

(v) The highest flood level marked on this bridge was 2′-11″ from the floor level.

Track

15. (i) The track on either side of the bridge is laid with 30′-0″ long 66½ lbs. FF rails manufactured by Barrow Steel Co., in 1885. When laid on this section in 1916, they were second hand rails released from the Broad Gauge. The sleepers used are Dowlais steel trough sleepers, 4-key type. They are provided at the rate of 12 per rail length or N+2. The fish plates are four holed 18″ long with ⅞″ square holes manufactured by B.V. & Co. Ltd. The fish bolts are ¾″ diameter snapheaded with square necks.

(ii) The sub-grade in bank is made up with local moorum. The sub-grade in the cuttings is hard moorum. The track is stone ballasted. There is no creep.

(iii) The height of the bank at the bridge is approximately 16 feet. This gradually goes on reducing till the alignment enters a cutting on either side. The cutting on Secunderabad side ends 119 feet short of the centre line of the bridge and that on the Dronachellam side starts 96 feet ahead of the centre line. The average depth of cutting on the Secunderabad side is 3′-9″, the maximum depth being 6′-6″ about 500 feet short of the bridge. The average depth of the cutting on the Dronachellam side is about the same.

Alignment and Gradient

16. (i) Jadcherla station is situated on a gradient of 1 in 1,000 rising towards Mahbubnagar. This grade continues for 1,380 feet beyond the centre line of the station. It is followed by 1,184 feet long up grade of 1 in 133, 288 feet long level stretch and about 3,700 feet long down grade of 1 in 150. Thereafter, the alignment consists of small lengths of rising gradients of 1 in 133, small level stretches and fairly long falling gradients of 1 in 133. Before reaching the site of the accident, there is a 3,600 feet long rising gradient of 1 in 133 followed by 470 feet level stretch and a 1 in 133 falling gradient. The accident occurred 506 feet after the point at which the falling gradient starts.

(ii) Before reaching the site of the accident, the train had to negotiate half-a-mile long right handed 2° curve in mile 59, 1/3 mile long right handed 2° curve in mile 61, 1/3 mile long right handed 1° curve and 1/3 mile long right handed 2° curve in mile 62, a 1/3 mile long left handed ½° curve in mile 64. The accident occurred on a left handed 2° curve. This curve commences 2,260 feet ahead of bridge No. 229 and continues for 380 feet beyond. The cutting commences almost at the beginning of this curve and continues beyond the end of the curve with a small break at bridge No. 229. All the curves are transitioned.

III. EVIDENCE

(i) *Dr. Feroz Hussain,* Civil Surgeon, Mahbubnagar, accompanied by his assistants, proceeded to the accident site with medical equipment by a private car immediately after he received the news. He reached the site at about 03.30 hours. He noticed refreshments being served to the passengers at the site.

(ii) *Shri Ramuloo,* son of Gateman, stated that about 15 minutes before the accident he heard noise of rushing water. He also heard gateman Balaiah urging the off duty gateman Nagaiah to go to bridge No. 229, as well as Nagaiah's reply that the bridge was no longer vulnerable since Pochani Kunta had already breached. Shortly after the crash he went to Appanapalli village and brought aid from that village.

(iii) *Shri N. B. Srihari,* Chairman, National Railway Mazdoor Union, Mahbubnagar Branch, states that he had stopped train No. 566 Up the previous day as it was raining but has no information which can throw light on this accident.

NOTE.—There was no water flowing over any bridge or any other untoward happening on that day. Six trains had run on this block section at normal speed till the time of the accident since the stoppage of No. 566 Up by Shri Srihari.

(iv) *Shri P. S. Konda,* Electrical Inspector, Central Railway, Construction Division, Secunderabad, was one of the first persons to get down from the train and start the rescue work. He noticed the guard had arranged to send a memo through a person on cycle at about 01.40 hours. He states that at about 03.30 hours medical aid arrived. He is unable to say whether there was any water on the cess but he noticed that the water was receding and went down by about 2 feet within 10 to 15 minutes. He did not notice a bridge watchman at the site. He had noticed that the first two third class coaches were crowded. He estimates, there were about 200 passengers in those two coaches.

(v) *Shri M. S. Prakasa Rao,* Guard, No. 565 Down on 1st September 1956, states that his train left Jadcherla at 00.24 hours. He received a heavy jerk on the run, fell down and saw the lights go out. He noticed the time then to be 00.40 hours. He immediately lighted his hand signal lamp and managed to switch the main side switch and relighted the train. He noticed gateman Nagaiah arrive at the site soon after the crash. He sent a memo through gateman Nagaiah to Jadcherla at about 00.50 hours. He rendered first aid along with other railway staff to some injured persons and then went and protected the train in the rear with the assistance of Shri M. Satyanarayana, Relieving Assistant Station Master, who was travelling in the train. At about 01.45 hours he sent another memo to Mahbubnagar through a volunteer, Shri Mohamed Sheriff. He states that there was no water on the cess. He did not notice what the water level was inside the bridge. At the time of the accident, it was raining moderately and it was pitch dark. Speed of the train, he estimates to be about 30 miles per hour. He had no field telephone on the train. He had first aid box which had

been checked and completely replenished about 10 days before the accident. He made attempts to find out if there was a doctor on the train but none could be traced.

(iv) *Shri K. Basanna,* Executive Engineer, P.W.D. (Irrigation), Mahbubnagar, has given the details of the catchment area, capacity, etc., of the Pochani Kunta. He states that the tank had an old breach which was taken up for repairs in 1951 and the work was nearly completed. The tank had again breached on 1st August, 1956.

NOTE.—The Chief Engineer, P.W.D. has intimated that the breach of Pochani Kunta has not been repaired since 1st August either fully or partially.

(vii) *Shri Sanjeevi Reddy,* Cultivator, residing about half-a-mile from Pochani Kunta states there was unprecedented downpour between 22.00 hours and 00.00 hours. He also noticed heavy thunder and lightning in the direction of Pochani Kunta at about the same time.

(viii) *Shri Iqbal Ahmed Razzaqui,* Deputy Superintendent of Police, Mahbubnagar, received the information of the accident at 03.10 hours. He immediately collected his staff and proceeded to the site of the accident. When he arrived at the site of the accident, he noticed the Civil Surgeon and the Railway medical staff rendering medical aid. He arranged for a search of the entire area for dead and injured. He also arranged to collect and guard the property of the passengers. By the evening of the 2nd, his party recovered 113 bodies. Three more were recovered on the 3rd and five on the 4th. He states that the search was carried out for 2½ miles down-stream up to the Namdar tank. He does not consider that there are any more bodies to be recovered from the tank and if any had been washed away further downstream, he would have heard about it. When he arrived at the site of the accident at about 04.00 hours, water level had receded to approximately half the height of the tender. On two dead bodies he found two wrist watches stopped at 12.40 hours.

(ix) *Dr. B. K. Roychowdhury,* Relieving Assistant Surgeon, Mahbubnagar, stated immediately on receipt of information he gathered his staff and equipment and proceeded to the site of the accident by Road Transport Department bus accompanied by the Permanent Way Inspector and other Railway staff. He reached the site at about 03.40 hours and immediately started rendering medical aid and rescue work. He states, four doctors who were at site before the breakdown special arrived had rendered all the necessary medical aid. He went round from compartment to compartment and inquired whether any more medical attention was required.

(x) *Shri P. Sathyanarayana,* Deputy Controller, states that the train left Jadcherla at 00.24 hours. He instructed the Assistant Station Master, Mahbubnagar to send for the Permanent Way Inspector and ask him to go and investigate as the train had not arrived till 01.00 hours. He states that at 01.25 hours the Permanent Way Inspector informed him that head light of No. 565 Down could be seen stationary at a distance and that he (Permanent Way

Inspector) was proceeding towards Jadcherla to investigate. At 02.35 hours, the Permanent Way Inspector informed him that there was a breach at mile 68/12 and that he had sent a memo to the driver of 565 Down to push back to Jadcherla. At 03.05 hours, he was informed by the Assistant Station Master, Mahbubnagar, that the train had met with an accident. He immediately instructed the Assistant Station Master, Mahbubnagar, to contact the local officials and also intimated the Loco Shed to turn out medical relief van and breakdown special. He relayed the information to the District Medical Officer and other officials almost immediately. He states that the medical special left Lallaguda at 03.50 hours.

(xi) *Shri B. Mukunda Rao,* Section Controller, states that he learnt, the train had not reached Mahbubnagar at 00.50 hours. At 00.58 hours, he instructed the Assistant Station Master, Mahbubnagar, to send the Permanent Way Inspector to investigate. Similar instructions were also given to the Assistant Station Master, Jadcherla, at 01.00 hours. At 01.25 hours, he states that the Permanent Way Inspector informed him that head light of No. 565 Down could be seen stationary at a considerable distance. At 02.35 hours, he was informed by the Permanent Way Inspector that the line had breached at mile 68/12 and that a memo had been sent to the driver of 565 Down to push back to Jadcherla. At 03.05 hours, he received the information about the accident and immediately conveyed it to the Deputy Controller, who took further action regarding arrangements of breakdown special, etc.

(xii) *Shri David Francis,* Assistant Station Master, Jadcherla, states that No. 565 Down left Jadcherla at 00.24 hours. At 00.50 hours, the Assistant Station Master, Mahbubnagar, intimated him that No. 565 Down had not then reached Mahbubnagar. At about 04.00 hours, he received information from the Divisional Operating Superintendent that the train had met with an accident and was instructed to arrange for medical aid. He immediately sent a memo to the local medical practitioners. He received the accident memo from the guard at 04.12 hours. He had noticed the head light of the engine burning as usual when it arrived at his station.

NOTE.—The control diary indicates that this Assistant Station Master was intimated about the accident at 03.12 hours, which he denies.

(xiii) *Shri Enkaiah,* Agriculturist (aged about 50 years, residing at Thigalapalli village near the water shed line of the catchment of Pochani Kunta), stated that there was unprecedented downpour accompanied by thunder and lightning between 22.00 and 24.00 hours. He had not seen such an intensity of rain in his life.

(xiv) *Shri Mohamed Hussain,* Retired Head Constable (aged 84 years, a resident of Kakerlapahad, another village near the water shed line of the catchment of Pochani Kunta), states that there was unprecedented rain between 22.00 hours and mid-night. He had not seen such an intensity of rain since 1907 when he was in Hyderabad.

(xv) *Shri B. Visweswar Rao,* Assistant Station Master, Mahbubnagar, received the "Train Entering Section" signal at 00.24 hours

and finding that there was no trace of the train intimated the Control at 00.55 hours. On the instructions from the Control, he intimated the Permanent Way Inspector to go and investigate. At 02.35 hours, he heard the Permanent Way Inspector inform the control about the breaches that had taken place between mile 68/8 and 68/12. At 02.55 hours, he received the memo regarding the accident through a passenger, Mohamed Sheriff. He immediately passed on the information to the Control and arranged to send messages to the local officials.

NOTE.—All the arrangements he made, however, were made some time after the information had been sent to the local officials, Road Transport Depot, etc., by the Permanent Way Inspector, who was at the station when the memo was received.

(xvi) *Kistappa Chinniah,* Patrolman No. 1, Jadcherla, brought the memo to Jadcherla station which was sent by the guard and handed over to him by patrolman No. 2. He stated that the head light of No. 565 Down when it passed him was burning but not brightly. Later, on re-questioning, he stated that the head light was not burning and what he meant was that the cab light was burning.

(xvii) *Shri Mohamed Yousuff,* driver of No. 565 Down passenger on 1st/2nd September 1956, left Jadcherla at 00.24 hours. At the time of the accident it was raining moderately and it was completely dark. He estimates the speed of his train to be between 25 and 30 miles per hour but his speedometer was out of order. He did not notice anything unusual at the bridge as he was coming round a curve nor did he hear water rushing. The jerk he felt was "as if he was going down and coming up". After the accident he found water rush into the cab and rise up to his neck but it soon started receding. He stated that the head light was properly burning and properly focussed. Later, on questioning, he stated that he had to change the head light holder and bulb at Umdanagar and before that he had to attend to it at Falaknuma. He did not notice any danger signal exhibited by the bridge watchman ahead of bridge No. 229.

(xviii) *Shri Narasimha,* first fireman of No. 565 Down of 1st/2nd September 1956 states that he changed the holder and bulb of the head light at Umdanagar and thereafter the focussing was not proper. He considers the speed of his train was approximately 30 miles per hour. He did not notice the level of the water as he climbed on to the roof of the cab immediately after the crash.

(xix) *Shri Sathiah,* second fireman of No. 565 Down Passenger of 1st/2nd September 1956, states that the head light bulb was changed at Umdanagar. At the time of the accident, it was moderately raining and very dark. He states that the head light of the engine was burning for about an hour after the accident.

(xx) *Shri Shaik Ismail,* driver of No. 805 Down goods leaving Jadcherla at 20.30 hours and arriving Mahbubnagar at 21.10 hours on 1st September 1956, did not notice the water level at bridge No. 229. He did not feel any jerk at the bridge or anywhere else between Jadcherla and Mahbubnagar.

(xxi) *Shri Kistadu,* patrolman No. 2 (Gang No. 19), states that No. 565 Down crossed him at mile 62 and at that time the head light of the train was burning but not brightly. On further questioning, he states that the head light was not burning and what he meant was cab lights.

(xxii) *Shri Adivigadu Balliah,* patrolman No. 3 (Gang No. 19), states that he left mile 67/8 at about 19.30 hours reaching the end of his beat at mile 64/14 at about 20.30 hours. He left mile 64/14 at about 21.30 hours and reached mile 67/8 at about 22.30 hours. After about half-an-hour he observed thunder and clouds in the direction of the hills. Anticipating heavy rush of water between the portion 68/7 and 68/10, which is tank affected and with previous history, he proceeded towards that side. When he reached mile 68/4, he observed red signal being exhibited by the bridge watchman at mile 68/9-10. He turned round and proceeded towards Jadcherla exhibiting danger signal. When he came to mile 67/11 he saw bridge watchman posted to look after bridges 229 and 233 placing detonators on the track. He instructed this bridge watchman to proceed towards Jadcherla and returned towards mile 68/9-10 to investigate. At mile 68/4 he found water overflowing the track and could not reach the watchman at mile 68/9-10. In his beat, he considers only bridge at mile 65/5-6 to be vulnerable but not the bridges at miles 66/15-16 and 67/9-10 as Pochani Kunta had breached. As bridge at mile 65/5-6 is near the gang quarters, he considered it would be advisable to proceed towards Mahbubnagar beyond his beat and make sure that the portion at mile 68/1-13 was watched. He had noticed the bridge watchman, posted to watch bridges Nos. 229 and 233, on duty on both occasions he went past bridge 229. On both occasions when he passed bridge 229 there was about 2 feet of water flowing under the bridge. According to him, normally, he meets the bridge watchman on the first trip forwards and backwards at bridge No. 229. On the date of the accident the bridge watchman was at bridge No. 229 on his return trip as usual and he had not come to bridge No. 233 till this man left for mile 68/4.

(xxiii) *Shri Bheemadu Naganna,* watchman at bridge No. 229 was understandably in a considerably confused state of mind. He states that he came on duty at about 18.00 hours at bridge No. 229. He stayed at that bridge till the patrolman No. 3 had passed the bridge and immediately thereafter went to bridge No. 233. After inspecting bridge No. 233, he stayed there for about half-an-hour and returned to bridge No. 229. While he was waiting at bridge No. 229, No. 805 Down goods passed over the bridge. He waited there till the patrolman went past the bridge on his return trip. After about half-an-hour, he proceeded to bridge No. 233. On the way he did not find patrolman No. 3 in his hut at mile 67/8. After inspecting bridge No. 233, he observed danger signal being exhibited from Mahbubnagar side. He, therefore, placed detonators about one telegraph post away towards Mahbubnagar and waited for the patrolman No. 3 to return. Patrolman No. 3 informed him that water was overflowing the track near mile 68/8-9. The patrolman also instructed him to proceed towards bridge No. 229. While proceeding towards bridge No. 229, he was exhibiting danger signal. When he was about 4 telegraph posts away from bridge No. 229,

he heard the train crash into the bridge. He states that the water level at the bridge, when he came on duty, was 2'-6" above the floor level. This had risen to 4'-6" when he left this bridge on the last trip to bridge No. 233 before the accident. As it was much below the predetermined level he did not consider the condition to be dangerous. During his duty hours he normally meets No. 565 Down Passenger when he is returning from bridge No. 233 to bridge No. 229. When he observed the train crash he proceeded towards Jadcherla by the P.W.D. road. This, he explains by saying that as he had learnt about the breaches and as he was in a confused state of mind he considered it would be possible to send the news to Jadcherla quicker than to Mahbubnagar. He also states that before the crash or afterwards he did not notice the head light of the engine burning. He states that he had an occasion to stop a train some time ago, *i.e.*, on 1st August, 1956, when the approaches of this bridge had been washed away. He states that he has been working for the last 15 years as night watchman and during that time he has never observed the water level at bridge No. 229 go above the high flood level mark.

(xxiv) *Shri M. M. Baig*, Travelling Ticket Examiner, Secunderabad, considers at the time of the accident there were about 100 to 150 people travelling in the first two coaches. He felt a jolt and saw the lights put out. He observed the time to be 00.39 hours and immediately got down and pulled the Kent couplers from the front compartment thus bringing lights on again in the remainder of the train. At that time it was raining and pitch dark. He then shouted for doctors but found none. He immediately organised rescue work and first aid operations with the help of other railway staff and passengers. Till the time of the accident he did not feel any unusual running. The first jerk that he felt, he considers, was like "iron striking iron". He felt two more similar jerks. He noticed that refreshments and tea were served to the passengers at about half past five in the morning. He did not notice the head light burning after the accident.

(xxv) *Shri F. Page*, driver of No. 554 Up Express of 1st September 1956, which left Mahbubnagar at 18.07 hours and reached Jadcherla at 18.28 hours on 1st September 1956, did not think that the water level in bridge No. 229 was anything unusual then. He noticed the watchman at this bridge while his train was passing. He did not feel any jerk either at bridge No. 229 or anywhere else between Mahbubnagar and Jadcherla.

(xxvi) *Shri Balliah*, gateman, Appanapalli, was the gateman on duty at the level crossing gate at mile 66/7-8 and when the train passed the gate he did not notice the head light burning. At the time of the accident it was slightly drizzling. He states that before the accident he had spoken to the off-duty gateman Nagaiah that he could hear the sound of water rushing and it would be advisable if he (Nagaiah) went and inspected bridge at mile 66/15-16 but Nagaiah replied "there is a watchman, the tank had already breached and so there was no danger to the bridge". While he was returning after accompanying Mohamed Sheriff along the P.W.D. road, he met the bridge watchman Bheemadu Naganna coming along that road.

(xxvii) *Shri K. Seshachalam,* Permanent Way Inspector, Mahbubnagar, states he has instructions to put on night patrol and special bridge watchmen at bridges carrying previous history at the commencement of the monsoon. He also has instructions to appoint special watchmen at tank affected bridges immediately the tanks get full. These had been appointed before the 1st August. All the bridges have been marked showing the predetermined level as instructed by the Chief Engineer. He has instructed the watchmen, patrolmen, and other staff to take action according to the Chief Engineer's circular. He receives weather warning telegrams whenever heavy rain is expected and when such a message is received he instructs his gangmen to be more vigilant. He also goes out to inspect vulnerable locations. He had received such a telegram on the evening of 31st August and had gone out and inspected bridge at mile 71/4-5 between 01.00 and 03.00 hours of 1st September 1956.

He had trollied over bridge No. 229 at about 13.00 hours on 1st August 1956 when he judged water level under the bridge to be 2'-0". He received the information about the washaway of the approaches of the bridge at 13.45 hours and immediately returned to the bridge reaching at 14.25 hours. At that time he has measured the depth of water to be 3 feet above the bed level. The washaway of the approaches had occurred due to breach in the bund of Pochani Kunta. But for this washaway, to his knowledge, there is no previous "history" for bridge No. 229 nor has he any record to show that water had eyer risen above 2'-8" from the floor level. He bases his statement on the examination of the section registers available up to year 1921. After the breach, he inspected the bridge structure and found it in a perfectly sound condition, even the pointing being in tact. He also found no evidence of scour. Washaway was made good by filling it with earth, boulders and coal ashes. The top 3'-0" height behind each abutment was made up with a 6' long sleeper crib and the section made up with coal ashes. The bank was gradually consolidated by addition of ballast and packing. The speed restriction was gradually relaxed till the 21st August when it was completely removed.

During this period, *i.e.,* from 1st August 1956 up to 1st September 1956, he has inspected this portion by various means on 17 occasions, the last one being by trolly on the 30th August. The track was checked by Hallade Track Recorder on 6th and 16th of August and on both occasions no defect was recorded at this bridge. He had checked the night patrolmen and night bridge watchmen by train on six occasions and had never found any cause to complain about their vigilance. As a matter of fact, on three occasions, during this monsoon his men have stopped traffic in this section, once by Bheemadu Naganna, who was the bridge watchman on duty when the accident occurred.

On the night of 1st/2nd September 1956, he was intimated about the non-arrival of No. 565 Down by the Assistant Station Master, Mahbubnagar, at about 01.00 hours. He immediately went to the station, contacted the Control and proceeded on trolly to investigate. When he reached mile 68/12-13 he found, the water was overflowing the track and the bank had breached at mile 68/11. As he was

unable to proceed further he deputed his mate to some how cross the breached portion *via* the P.W.D. road and take a memo to the driver of No. 565 Down, which he was sure would have been stopped on the other side of the breach, instructing the driver to push back to Jadcherla. He had not been able to see the head light of this train nor was he aware that the train had met with an accident. He returned to the station to transmit the information regarding the breach at 02.45 hours. While he was at the station, a passenger from No. 565 Down came there on bicycle with the accident message. Immediately he arranged for the information to be conveyed to the local officials and to the Railway Surgeon. He also arranged for the Road Transport Department buses. He reached the site of accident at about 03.45 hours and immediately engaged himself in rescue operations.

NOTE.—It is recorded in the Control diary that the Permanent Way Inspector informed that the stationary head light of No. 565 Down was visible. The Permanent Way Inspector, however, denies having given this information. He further adds that it could not have been possible for him to see the head light if the train was standing at bridge No. 229. This, on verification, was found to be correct.

(xxviii) *Shri Sayanna Hanumiah,* watchman, bridge Nos. 204 and 207 and *Shri Golla Channappa,* watchman, bridge Nos. 221, 222 and 226, both stated that they noticed that the head light of No. 565 Down was not burning when it passed them.

(xxix) *Shri Anupala Naganna,* gateman, Appanapalli gate, denies having discussed with the other gateman, Balaiah, regarding the water rushing through bridge No. 229.

(xxx) *Shri Jalal Saib Bande Ali,* gangmate, Gang No. 19, states that he was woken up at about 02.00 hours by Bheemandu Nagannah, bridge watchman, and informed about the accident. When he arrived at the accident site there was no water near the engine. Since the wash-out on 1st August 1956, the approaches of this bridge had been attended to on 12 occasions by the gang.

(xxxi) *Shri P. C. Padma Rao,* Assistant Engineer, Secunderabad-Dronachellam section, Secunderabad, states that he has instructions to put on night patrolmen and bridge watchmen at bridges carrying past history and at tank affected bridges. This had been done prior to the commencement of the monsoon this year. He has instructions to inspect such of the bunds of railway affecting tanks as may be required by the Divisional Engineer but had no instructions regarding the bund of Pochani Kunta. He has instructions also to inspect all bridges and send a certificate to the Divisional Engineer by the 15th of January each year, which he has done. The bridge registers are available from the year 1937 and since that time no "previous history" has been recorded for bridge No. 229. The yearly high flood level used to be entered in the Assistant Engineer's inspection not before introduction of the new bridge registers, which commenced in 1950. In the new register only the highest flood level is recorded. After the breach, the traffic was restored with speed restriction which was gradually relaxed till it was completely removed on 21st August 1956. Between 1st August and 1st September, he has inspected the track by

train and trolly on seven occasions. He did not find anything wrong at the approaches of bridge No. 229 during any of his inspections. He had no occasion to find fault with the work of night patrolmen or bridge watchmen.

(xxxii) *Shri E. Alphansus,* Electrical Inspector, found no defects in the wiring of the head light. He considers the focussing of the head light was not proper. He states that due to short supply of holders, improvised ones are being used. He does not consider, from the examination of the leads of the improvised holder, that a proper connection could have been made. He does not consider that the head light could have been dim, either it was bright or it was not burning at all. He found the turbo-generator in good working order.

(xxxiii) *Shri Narasimha Devanna,* Electric Head Light Fitter, Lallaguda, states that the engine of No. 555 Down was fitted with J. Stone manufactured holder when it left Lallaguda Shed on 1st September 1956 and the head light was properly focussed.

(xxxiv) *Shri S. Yasin Ali Khan,* Divisional Engineer (West), Secunderabad, states that he has instructions to provide watchmen for vulnerable bridges. For watching, bridges are grouped together upto a length of one mile according to the Chief Engineer's instructions. He does not consider that this length of beat can prevent a watchman from keeping an effective watch over the bridges. He considers the breach of Pochani Kunta has eliminated vulnerability of bridge No. 229. The watch was continued as the approaches were newly made and, therefore, had to be watched according to the Chief Engineer's instructions.

After the washway of 1st August 1956, he had minutely examined the masonry, foundations, bed blocks, flooring and girders of this bridge and found them to be in a perfectly sound condition. The breach had been made up with boulders, coal ashes and local moorum and top 3 or 4 feet with sleeper cribs. Old pitching on two wing walls had been restored. He has no reason to doubt correctness of the high flood level recorded on this bridge. He considers the waterway may have been designed on Dickens's formula taking the constant to be 800. He also considers that the siting of the bridge was probably perfect when the bridge was built in 1916 and possibly the channel has slightly shifted making a slight skew crossing with the track as it now exists. He considers, as there was no adverse effect during the last 40 years, re-consideration of the siting of the bridge does not appear necessary. He states that the fixed end of the girders was on the Dronachellam side.

(xxxv) *Shri R. Hydari,* Divisional Superintendent, Central Railway, Secunderabad, received the intimation regarding the accident at 03.15 hours and was also told that medical relief train had been arranged. This train left Lallaguda at 03.52 hours and arrived at the site with the District Medical Officer and others at 06.49 hours. On arrival at the site, he found that all the injured had already been attended to and the passengers had been supplied with refreshments. He considers there were 314 passengers on the train at the time of the accident. An Information Office was opened at Secunderabad and arrangements were made to convey news and messages as and when necessary. Arrangements were also made to convey passengers and

mail by Road Transport Department buses till through running was restored. He considers the breakdown special could not be run at express speed as the medical van is not a bogie carriage.

(xxxvi) *Shri F. X. Lobo,* Deputy Chief Engineer (South), Central Railway, Bombay, got the information about the accident from the General Manager at 04.10 hours and reached the site at about 13.45 hours. He has stated the various precautions that have been taken in recent years for protection of trains. The chief precaution affecting the bridges under the circumstances was, examination of bridge records for past 15 or 20 years and providing watch over vulnerable bridges during monsoon. A list of all bridges having previous history was prepared. A list of all bridges affected by the tanks was obtained from the Public Works Department. All these bridges were inspected by him and necessary instructions given. Bridge No. 229 was not one of the bridges inspected by him as this bridge had no previous history nor was it included in the list of tank affected bridges. Later on, the Divisional Engineer found that this was a tank affected bridge and had taken action regarding its protection according to the instructions issued by the Chief Engineer. The high flood level at this bridge was recorded to be 2'-11" above floor level in 1938 and he has no reason to doubt authenticity of this. The masonry of the unaffected portion of this bridge and of other bridges nearby is excellent. He states the pre-determined levels were decided upon only on rational basis. They are not based on any formula or other considerations. He did not consider it possible to examine the effect of flood upto the predetermined level on each and every bridge and as such, in addition to all other instructions, the watchmen also have instructions to take suitable action if the bank gets affected whatever the water level. He considers that effective watch can be kept by a watchman over a mile-long beat. He considers that after the breach of the tank affecting bridge No. 229, the bridge was no longer vulnerable.

(xxxvii) *Shri N. M. Thadani,* Chief Engineer, Central Railway, Bombay, got the information while he was on his way to Delhi. He reached the site of the accident at 14.30 hours on 3rd September 1956. He states, large number of precautionary measures for the protection of bridges have been taken and the important amongst them, under the circumstances, are, scrutiny of previous history, appointment of watchmen at vulnerable bridges and fixing of predetermined levels. The watchmen have instructions to stop traffic and take certain precautions whenever the water rises above the predetermined levels or whenever any adverse effect is observed on the bridge or its approaches, even when the water level was below the predetermined level. Arrangements were made with Meteorological Department to issue weather warnings. State Governments were requested and agreed to inform the Railway whenever the railway affecting tanks got full. The predetermined levels were fixed by leaving a reasonable margin of safety below the girders. This margin was more than that required by Para. 1713(b)(i) of Way & Works Manual. No other factors were taken into consideration as it was considered that all structurally sound bridges should be capable of carrying water upto the full waterway available. He considers it is not practicable to take cognizance of other considerations and work out the case for every bridge but overall instructions issued to stop traffic if the

bridges were adversely affected, even before predetermined level was reached, are sufficient. The question of re-siting bridge No. 229 was not considered as this bridge had no "previous history" nor was the bridge structure affected by the washaway that occurred on 1st August 1956. Moreover, this washaway was due entirely to the breach of the tank bund. After the breach of the tank bund, this bridge was no longer vulnerable but watch was continued as the approaches were new. He considers a watchman should be able to maintain an effective watch even in hilly country over a beat one mile in length.

(xxxviii) *Dr. B. V. Pulla Reddy,* District Medical Officer (1), Central Railway, Secunderabad, arrived at the accident spot at 06.45 hours by the medical relief train. He deposes that at the site he found all the persons requiring medical aid had already received it. He examined all the cases available at site and arranged for the transport of the serious ones to Lallaguda hospital. Later on, he examined the cases in Mahbubnagar Government Hospital with the Chief Medical Officer and arranged for the transport of the serious cases from that hospital also to Lallaguda hospital where better facilities are available. He considers the medical equipment of the medical relief van is adequate but is not aware of any proposals regarding provision of a bogie van instead of a six-wheeler. He considers the "C" scale equipment would be more useful if half-a-dozen haversacks with first aid kit are included in this equipment.

(xxxix) *Shri R. L. Mitra,* Divisional Electrical Engineer, Central Railway, Secunderabad, examined the leads of the improvised holder of the engine head light. He considers a good joint cannot be made with those leads and it is possible for a joint made from those leads, of the improvised holder, to have become disjointed on the run. He states that J. Stone manufactured holders cannot cause a bulb to fuse but they are in short supply.

IV. DISCUSSION

Time of the accident

18. (i) The train crew, the Assistant Station Master, Jadcherla, and the Section Controller state that No. 565 Down passenger left Jadcherla at 00.24 hours. Departure time of this train as shown on the Control chart is also 00.24. I accept this to be correct. This train has neither lost nor made up any time on the run since it left Secunderabad. I, therefore, consider, the driver was generally keeping to the running time allowed.

(ii) After leaving Jadcherla, it has travelled 7.5/8 miles before meeting with the accident. The running time for this train between Jadcherla and Mahbubnagar is 20 minutes. Normally, it should have taken about 14 minutes to reach the site of the accident. This indicates the time of the accident to be 00.38 hours.

(iii) The time of the accident as noted by the guard is 00.40 hours. Two wrist watches, which had stopped exactly at 00.40 hours, have been discovered on two dead bodies. These watches probably stopped shortly after the accident due to shock of and immersion in the flood. Probably, there was a slight time lag in these timings. The

Travelling Ticket Examiner, Baig, noted the time of accident to be 00.39 hours. This nearly agrees with the timing arrived at on other considerations and is probably correct. I, therefore, consider the time of the accident to be 00.39 hours.

Speed of the train

19. (i) The maximum permissible speed for passenger trains drawn by YP engines is 40 miles per hour. The running time permitted for this train between Jadcherla and Mahbubnagar to cover a distance of 11 miles is 20 minutes. Allowing one minute each for acceleration and stopping and assuming the distance covered during that time to be half-a-mile, the average speed works out to 35 miles per hour. The train has taken 15 minutes to cover a distance of 7.5/8 miles upto the site of this accident. Allowing one minute for acceleration and assuming the distance covered in that time to be ¼ mile the average speed, upto the site, works out to be 31.6 miles per hour.

(ii) The guard has estimated the speed of the train at about 30 miles per hour. The driver and his crew have estimated it between 25 and 30 miles per hour. The passengers in the train have all stated that the train was proceeding at usual speed.

(iii) It is possible that the train crew might have tried to estimate the speed slightly lower than it actually was.

(iv) The train has taken 15 minutes to travel 7.5/8 miles. It has negotiated a 3,600 feet long 1 in 133 up grade upto about 970 feet short of the site. It was then raining. Taking into account all these factors, I consider the speed of the train must have been about 30 miles per hour at the time of the accident.

Condition of the stock

20. (i) The engine had been on line since 17th July 1954 and had completed approximately 1,25,000 miles. It was not due for periodical overhaul till after another 25,000 miles. It has received C. & W. schedule on 16th June 1956, monthly examination on 19th August 1956 and washout on 1st September 1956. Since the washout, it had covered only 66 miles. The engine had no defects nor were any noted in the repair books likely to render it prone to accident.

(ii) The tender was put on line on 7th February 1955. It had completed approximately 1,06,000 miles and was not due P.O.H. till after another 44,000 miles. It had received its monthly examination on 19th August 1956. This tender has been attached to this engine since 19th May 1956 and has given no cause for anxiety.

(iii) Coach No. TY 0221 had received its last P.O.H. from 7th May 1956 to 7th June 1956 and had been on the line for less than three months since.

(iv) Coach No. GT 94 had received its P.O.H. from 25th June 1956 to 16th July 1956 and had been on line hardly a month and a half since.

(v) Coach No. FCS 152 was a newly built coach. This had received its last P.O.H. on 18th June 1955, repacking on 22nd July 1956 and oiling on 22nd August 1956. It was due for P.O.H. in December 1956.

(vi) None of these coaches had any defects which would have rendered them liable to accident.

(vii) I consider the condition of the stock was good and could not have caused or contributed to the accident.

Condition of the track

21. (i) I have travelled three times between Mahbubnagar and Secunderabad since the accident and have particularly watched the running qualities of the track between Mahbubnagar and Jadcherla. I have found the running to be excellent.

(ii) The sub-grade is good moorum. The track is fully ballasted and there is no creep.

(iii) Since the washaway that occurred at bridge No. 229 on 1st August 1956 the track between Jadcherla and Mahbubnagar had been inspected by the Permanent Way Inspector 17 times, by the Assistant Engineer 7 times and by the Divisional Engineer twice, either by train, trolly or engine. On none of these occasions have any of them found any defects in the track and particularly at the approaches of bridge No. 229.

(iv) The Hallade Track Recorder has passed over this section on the 6th and the 16th of August 1956. On the first occasion it passed when there was a speed restriction of five miles per hour at bridge No. 229 and on the second occasion when the speed had been raised to 20 miles per hour. There are no defects recorded on the approaches of bridge No. 229 on either occasion.

(v) The gang chart shows that the approaches of the bridge and track in the neighbourhood has been attended to by the gang since 1st August 1956 on 12 occasions.

(vi) Attention given to the approaches of bridge No. 229 since 1st August 1956 and my observations lead me to the conclusion that the maintenance was excellent. The Permanent Way, therefore, could not have caused or contributed to the accident.

Condition of the bridge No. 229

22. (i) The approaches of this bridge had been washed away on 1st August 1956. After this washaway the Engineering officials had an excellent opportunity of examining the structure of this bridge in detail. Having done so, the Permanent Way Inspector, the Assistant Engineer and the Divisional Engineer have all stated that the bridge structure was in an excellent condition. There were no cracks and even the pointing had not been disturbed. They have also stated that the flooring was in tact and there was no evidence of scour.

(ii) After this accident, the undamaged portion was again examined by these Engineering officials and again they found the condition of that portion of masonry sound. The Deputy Chief Engineer, who has also examined the undamaged portion of the masonry confirms this observation.

(iii) This is further corroborated by examination of the section register which does not reveal any structural defect in this bridge. The only attention of any importance that has been paid to this

bridge since it was built, in 1916, was renewal of bed timbers by C.C. bed blocks; one in 1934 and the other in 1938.

(iv) I examined the undamaged portion of the masonry of this bridge. I have also examined other bridges in the vicinity built during the same period and have come to the conclusion that structurally the bridge was sound before the accident.

Head Light

23. (i) The engine of No. 565 Down Passenger left Lallaguda Shed with a head light properly focussed. The head light was fitted with a projector lamp holder manufactured by J. Stone & Co. It can, therefore, be assumed that the beam of light conformed with the I.R.S. specification No. E9-1953 quoted below:—

> "The projector shall be of the concentrated beam type and shall be fitted with a 14" or 18" diameter reflector as specified by the purchaser and a 250 watt 32 volt lamp which shall project a beam not less than 1,000 feet in length. The intensity at a point in the centre of the beam at that distance be not less than 0.3 foot-candles and the angles of the beam shall be not less than 7°".

The voltage of the turbo-generator on load after the accident was found to be 28. The intensity of the beam, therefore, should have been slightly less than that specified by the Railway Board.

(ii) At Falaknuma, the driver found that the bulb had worked loose and had to be tightened. At Umdanagar the driver found that the bulb had fused. At this stage, he has, rightly or wrongly, attributed the fusing of the bulb to the J. Stone type holder and got it exchanged for a locally manufactured one. It is possible that this assumption on the part of the driver was wrong. The Divisional Electrical Engineer has emphatically stated that J. Stone type holders cannot possibly be the cause of fusing the head light bulbs. The locally improvised holder is a plastic holder screwed to a piece of wood with leads taking off which can be connected to the wires from the turbo-generator. This piece of wood is tied on to the cross arm of the head light and the bulb screwed into the plastic holder pointing towards the engine. Under these circumstances, the focussing of the head light can, under best conditions, not be perfect. The driver has stated that the focussing of the head light was good. The first fireman on the other hand is of the opinion that the focussing was not upto the usual standard. The Assistant Station Master, Jadcherla, and three pointsmen of Jadcherla stated that the light was burning when the train arrived and left Jadcherla though two of the pointsmen consider that the head light was dim. After leaving Jadcherla, the train has passed by two night patrolmen, two bridge watchmen and one level crossing gateman. They are all unanimously of the opinion that the head light was not burning. After the accident, the second fireman states that the head light was burning for about an hour. Against this, however, there is overwhelming evidence to show that at the site it was pitch dark after the accident. If the head light was burning, it certainly would have thrown some diffused glow and attracted considerable attention. It can, therefore, be safely assumed that the head light at that time was certainly not burning.

(iii) The Loco Inspector who disconnected the head light after the accident and the Divisional Mechanical Engineer, who was present at the time, emphatically stated that the connection, between the leads of the improvised holder and the leads from the turbo-generator, was properly made. The lead ends of the improvised holder have been examined by the Divisional Electrical Engineer and the Electrical Inspector. They are of the opinion that with those leads a good work-manlike connection cannot be made and it is possible that a joint made may get disconnected due to vibrations on the run.

(iv) The turbo-generator and other electrical connections were carefully examined and were found in perfectly good working order. The light switch in the cab was also examined and it was found that the head light could not have been accidentally dimmed. The head light should either have been full on or have been put out. Evidence on this point is conflicting and it is not possible to come to a definite conclusion whether the head light was working or not before the accident. It is possible that the leads were making intermittent contact and the head light was being put on and off.

(v) Assuming that the light was full on and probably focussed, the visibility, under best conditions in this light, is about 1,000 feet. Even in that range it has been found, by experiment, conducted in connection with the Calcutta Mail accident at Sullurupeta, that any disturbance of the rails on a straight road can be noticed only when the engine comes to within 300 feet and that too at a slow speed and with foreknowledge of the disturbance. A sag or disturbance of the subgrade would, therefore, be much less noticeable. In the present case, the engine was approaching the accident site on a 2° left handed curve and in a cutting. When a visibility test was made under almost similar conditions, it was found that from the driver's side the view of the bridge is obstructed by the boiler of the engine. The bridge comes into view when the engine comes to within 100 feet of it—a distance much too short for a driver to take any effective action. The normal stopping distance for a Metre Gauge passenger train travelling at 30 miles per hour, under best conditions, is about 500 feet. (Authority Railway Board's letter No. 5897/TT, dated 5th September 1956). To this, must be added the considerations for wet weather, down gradient and obstructed visibility.

(vi) Even with a very efficiently maintained head light, there are bound to be circumstances such as thick and foggy weather, curves in a cutting which reduce the visibility available to the driver. Under these circumstances, a driver is still expected to take his train at normal speed unless he has cause to apprehend dangerous conditions or has been given a caution order. In this connection, General Rule 89(b) reads:—

> "The driver shall regulate and control the running of his train as accurately as possible according to the Working Time Table, so as to avoid either excessive speed or loss of time".

The situation of the present accident was one such condition where the driver had limited visibility.

Assuming that the head light was not working, General Rule 143(c) lays down:—

> "When in accordance with sub-rule (a) an electric head light is used on a locomotive other than an electric locomotive the engine shall carry at least two oil head lights for use in case the electric light fails".

The Subsidiary Rule in force on the Central Railway to the General Rule is:—

> "Should electric head light suddenly fail when working a train or light engine, the driver shall take the following action:—
>
> (a) if at a station, light up the buffer lamp as shown above before starting;
>
> (b) if on the run, promptly bring his train to a stop and light up buffer lamps as shown above before re-starting".
>
> NOTE:—"as shown above" in the two clauses quoted refers to the various positions of the buffer lights to distinguish different types of trains.

Sub-rule C (i) on the same railway is:—

> "in such cases (when the engine is being driven on buffer lights) speeds of the trains shall be reduced to 40 miles per hour on Broad Gauge and 35 miles per hour on Metre Gauge".

The visibility available to the driver with buffer lights is practically 'nil'. Therefore, the driver is expected to run upto 35 miles per hour without any assistance from visibility under normal conditions.

(vii) No. 565 Down was running on the day in question under normal conditions obtained during the monsoon in that section. The driver had not received any caution order nor was there any cause for a caution order to be given. The driver did not apprehend any dangerous conditions nor had he any cause to do so. He was running at about 30 miles per hour, which is within the permissible limit of 35 miles per hour when running on buffer lights only. Assuming that the head light had gone out, the failure on the driver's part in not lighting up the buffer lamps can be considered as a technical failure. Under the circumstances obtaining at the site, the driver could not possibly have brought his train to a stop in time to avoid the disaster whether the engine head light was properly focussed or not, was full on or dim, was burning or had been put out.

(viii) I am, however, inclined to give the benefit of doubt to the driver and consider that the head light, though not properly focussed, was in all probabilities burning till the accident and was probably put out at the time of the crash.

Protective measures

24. Certain precautionary measures have been in force on the Central Railway as on other railways for a long time. The Central

Railway, however, had the sad experience of Jangaon accident. After the Jangaon accident, the Central Railway has taken elaborate precautions and these are embodied in the various circulars issued by the Chief Engineer in this connection.

(A) *Bridges with past history*

(i) The first circular to be so issued is No. W/131M.52-D/3, dated 13th November 1954 modified by letter No. W.131-M-52-D/61, dated 10th May 1955, *vide* Appendix I(A). The main features of this circular are:—

(a) to prepare a list of all vulnerable locations where damage to the formation and breaches had occurred during the monsoon of 1954;

(b) to study the history of such locations;

(c) to formulate proposals for remedial measures;

(d) to take action to implement remedial measures; and

(e) where it was found not possible to complete the remedial measures, to employ special watchmen to keep a vigilant look out and, if necessary, impose speed restriction.

(ii) The Divisional Engineers were instructed to study the past history of all bridges and personally inspect such bridges or locations, which had suffered damages by floods. They were then expected to make out proposals for remedial action.

(iii) The Zonal Deputy Chief Engineers were expected to study these reports from the Divisional Engineers and, if necessary, after personal inspection, finalise the remedial measures. The remedial measures were to be carried out on urgency certificates. Where it was not possible to complete the remedial measures, a watch had to be kept.

(iv) Detailed instructions were also given to the Assistant Engineers regarding the routine inspection of bridges. Their special attention was drawn to scours, disturbances of pitchings and other protective works. Similar instructions were also issued to the Permanent Way Inspectors.

(v) Instructions were issued for recording high flood levels and soundings in case of certain important bridges.

(B) *Tank affected bridges*

The Divisional Engineers were instructed to make out a list of all tank affected bridges. Such tank affected bridges had to be watched by special watchmen by day and by night. Each Watchmen had to watch one bridge or a group of bridges situated within one mile of each other. The watchmen, however, were to be employed only after the tanks got full.

(C) *Predetermined levels*

(i) Instructions were issued to mark on all bridges what were called "predetermined levels". The "predetermined levels" were decided upon on rational basis leaving an extra margin of safety over and

above that required by Para. 1713(b)(i) of the Way and Works Manual, which reads:—

"Apprehend damage to line when—

(i) the flood is higher than any previous flood or is within 4 feet of rail level or is touching a girder or nearly touching it".

(ii) As soon as the water level reached the "predetermined" marks, the watchmen had instructions to stop traffic. The traffic could then be resumed only after the bridge had been tested and certified by an Engineering Official.

(D) *Vulnerable locations*

(i) The Divisional Engineers were also instructed to make out a list of all vulnerable locations, other than bridges, liable to be damaged by floods. Deputy Chief Engineers had to scrutinise this list and issue instructions, if necessary after personal inspections, regarding remedial measures to be adopted.

(ii) The instructions mentioned above were further amplified and related to the various chapters and paras. of the Way and Works Manual in the Chief Engineer's circular No. W.131M.54D/2, dated 30th November/2nd December 1954, *vide* Appendix I(B).

(E) *Railway Board's instructions regarding bridge inspections*

(i) The Railway Board in the meanwhile issued certain instructions, regarding inspections of bridges, in their letter No. 54/W/10/31, dated 2nd December 1954, *vide* Appendix I(C). The more important instructions are:—

(a) History of bridges should be studied by the Deputy Chief Engineers for a period of 15 to 20 years and note bridges that have a "previous history" (without distinction such as major or minor).

(b) Such bridges should be personally inspected by Deputy Chief Engineers who should satisfy themselves that they are safe and likely to remain so under flood conditions. The Deputy Chief Engineers were to particularly examine bridges with open foundations and inspect them with a view to determine the adequacy of waterway in cases of those recording abnormally high floods and heavy afflux.

(c) Information had to be collected regarding works undertaken by other departments, which might adversely affect the safety of railway bridges.

(d) All protective works undertaken by the railways with regard to bridges had to be inspected.

(e) The Deputy Chief Engineers had to take action in consultation with the Chief Engineer regarding measures to be adopted immediately, measures to be adopted as a long term policy and instructions to be issued regarding action to be taken during monsoons and abnormally heavy rainfall.

(ii) These Railway Board's instructions were amplified and conveyed to the Divisional Engineers in Deputy Chief Engineer's (South) letter No. W.131.M.54.D, dated 17th December 1954, *vide* Appendix I(D).

(iii) These instructions were followed and necessary inspections had been carried out at various levels.

Predetermined levels and high flood levels

25. (i) The predetermined levels that have been fixed by the Chief Engineer are based on adopting an extra margin of safety over and above that suggested in Para. 1713(b) (i) of the Way and Works Manual. Recorded high flood levels, catchment areas, nature of local terrain, angle of the impingement of the stream and such other factors were not considered in fixing the predetermined levels. On most of the bridges, the high flood levels have been recorded during the last 40 years or more. In case of a bridge without previous history, therefore, the recorded high flood level is a guarantee that the bridge and its approaches are perfectly safe during floods upto that level. In some cases, the predetermined levels are much higher than the recorded high flood levels. The action of flood of an intensity between these two levels is an unknown factor. It is possible that there may be a case where safety of a bridge may be affected at any level between these two. The watchmen and night patrolmen, however, have overall instructions to take action as per CE's circulars if any adverse effect is observed on a bridge or its approaches. This can be effectively done only if rising flood can be kept continuously under observation. This may not be possible when a few bridges are grouped. The watchman will have to decide whether to stay at a particular bridge and watch the effect of the rising flood or to go on his round. It would be desirable not to leave this important factor to the discretion of bridge watchmen and night patrolmen. Additional instructions, to take action detailed in the Chief Engineer's circulars immediately the water level reaches either the high flood level or the predetermined level whichever is lower, appear advisable.

(ii) It has been argued that such a course would cause considerable dislocation of traffic. This argument does not appear to be tenable. In most cases, the high flood levels are highest levels reached during the last 40 years or more. It is not likely that these levels would be exceeded in more than a few cases every year. Considering the element of safety this precaution will introduce, stoppage of trains on a few occasions should not be allowed to militate against this measure.

Classification and equipment of bridge watchmen

26. (i) The Chief Engineer in his circular No. W. 131M52.D/3, dated 13th November 1954 modified under his letter No. W.131M52-D/61, dated 10th May 1955 lays down, "the number of watchmen to be employed can be reduced by grouping of adjacent bridges in whose catchments railway-affecting tanks lie within a distance of, say, one mile". A watchman would require one hour to walk from one end of his beat to the other and back. In addition, he has to examine bridges in the group which may require some more time.

A vulnerable bridge thus may not be under his watch for a period of considerably more than one hour at a time. In certain areas, flood can come in much shorter time. In such areas, it appears prudent to reduce the beat of bridge watchmen to such lengths as would enable the bridge watchmen to keep a continuous and effective watch over the bridges in that length.

(ii) The bridge watchmen are at present classified "essentially intermittent". This classification pre-supposes periods of inactivity of a duration exceeding one hour. In the areas subject to sudden floods it is essential that the bridges be given sustained attention. If the bridge watchmen have to give sustained attention to the bridges, they should necessarily be classified as "continuous", particularly in such areas.

(iii) The bridge watchmen and night patrolmen are provided with hand signal lamps. These lamps are capable of showing indication only in one direction. It is desirable that they are equipped with trolly lamps which can give indications in both directions. The trolly lamps can easily be planted in the track and can give a warning to the traffic approaching from either side thus increasing the margin of safety.

(iv) The night patrolmen and bridge watchmen are expected to observe the effect of flood on banks and water level at bridges with the aid of the hand signal lamp. It is hardly possible for them to properly assess the situation by this lamp. It is desirable that they be equipped with three-cell electric torches to enable them to keep a more effective watch.

Precautionary measures regarding railway affecting tanks

27. (i) The Chief Engineer of Central Railway in consultation with the Chief Engineer, Irrigation, P.W.D., Hyderabad, issued a joint draft circular, dated 12th March 1955, *vide* Appendix II. The main features of this circular are:—

(a) A list of railway affecting tanks be prepared by the Chief Engineer, Irrigation, P.W.D., Hyderabad, on certain basis given in the same circular.

(b) An extract of these lists be given to all the Divisional Engineers of the Railway.

(c) The Sub-divisional officers of the P.W.D. to inspect each railway affecting tank as soon after monsoon as possible and submit a report by the end of January with a copy to the Divisional Engineer (Railway).

(d) The P.W.D. authorities to take action to carry out any repairs necessary to the railway affecting tanks before next monsoon.

(ii) The Divisional Engineers are expected to scrutinise the reports of the Sub-divisional officers and pick out such of the tanks they consider to be not in a satisfactory condition of repairs and instruct the Assistant Engineers to inspect them. The Divisional Engineers, on receipt of the Assistant Engineer's report, are expected to contact the P.W.D. authorities and request them to effect necessary repairs.

(iii) The General Manager of the Central Railway addressed the Chief Secretaries of Andhra and Hyderabad States by D.O. letters requesting them to instruct various Revenue officials to intimate to the nearest Station Masters whenever the railway affecting tanks become full. This request of the General Manager was agreed to by the Chief Secretaries of both Andhra and Hyderabad States and necessary instructions were issued by them to the revenue officials.

Patrolling of the line during monsoon months

28. (i) Instructions were issued for patrolling of the line in Chief Engineer's circular No. 46 (Revised), dated 18th April 1955, *vide* Appendix III. This circular is based on the instructions contained in the Way & Works Manual. The main features of the circular are:—

(a) Best and most reliable men from each gang are selected for this duty;

(b) The patrolmen are expected to walk over their beats according to the time tables laid down and carefully observe condition of the line;

(c) The Permanent Way Inspectors are instructed to personally instruct the night patrolmen both orally and by demonstration in their duties and responsibilities;

(d) A record of the time of their departure and arrival is to be maintained in the Station diary.

(ii) These patrolmen were specially instructed to apprehend danger whenever:—

(a) the flood level exceeds predetermined level;

(b) when water level on one side of the embankment is much higher than on the other;

(c) when erosion of embankment at the approaches of a bridge has started;

(d) when obstruction blocks the waterway of a bridge;

(e) when track shows signs of settlement.

(iii) Under these and other conditions under which the watchman apprehends danger, he has to immediately protect the line by use of red light and detonators and also report to the nearest Station Master. On receipt of such a report, the Station Masters are expected to stop all traffic and inform the Engineering officials. The traffic can only be resumed after an Engineering official not below the rank of a Sub-Permanent Way Inspector has certified to its safety.

(iv) The Permanent Way Inspectors are expected to check the attendance and work of these men four or five times a month and the Assistant Engineer once a month.

(v) In addition to the night patrolmen, special watchmen had to be appointed to watch bridges known to have given trouble or were tank affected and ghat sections subject to rock falls. These watchmen also had to take action on the same lines as the night patrolmen when danger was apprehended, *vide* Appendices I(A) and III.

Weather warning telegrams

29. Arrangements were made with the Meteorological Department to intimate the Chief Controllers of various areas whenever heavy rain in those areas was anticipated. The Controllers are instructed to intimate the Station Masters who in turn have to intimate the Permanent Way Inspectors regarding expected heavy rain. The Permanent Way Inspectors are expected to alert their men to be specially vigilant. In case of heavy and prolonged rain, the gangs are expected to patrol the line in addition to the normal night patrolmen and bridge watchmen. In serious cases or when the Permanent Way Inspectors themselves felt that dangerous situation may arise they are expected to be out and vigilant, *vide* Appendix IV.

New Bridge approaches

30. (i) In addition to the normal night patrol, the bridge watchmen and other watchmen posted at vulnerable locations, instructions were also issued to watch newly formed banks by the Chief Engineer in his No. W.131.P-D, dated 6th July 1956, *vide* Appendix V. The Chief Engineer, during one of his inspections, noticed that newly formed approaches of a bridge had sunk. He, therefore, issued general instructions that such places, even though consolidated, should be watched for one monsoon.

(ii) This circular does not make it clear whether such watchmen are to be exclusively posted to watch one bridge alone or whether watching of a bridge with newly formed approaches is to be grouped with other bridges close-by upto the one mile limit laid down in the other circular.

Reminder

31. Before beginning of the monsoon, the Chief Engineer exhorted his men to be vigilant by a notification in the Central Railway Weekly Gazette No. 22, dated 8th June 1956. This circular drew attention of the staff to the various precautions that had to be taken and also instructed them to be prompt and vigilant.

Night Patrol System

32. (i) The Chief Engineer's circular No. 46 (Revised) is accompanied by a typical example of night patrol time-table. The night patrolling based on this time-table starts at 18.00 hours and ends at 06.00 hours irrespective of the train service. Under this system of night patrol, there are portions of tracks which are not patrolled for a period upto $5\frac{3}{4}$ hours at a stretch. It is likely that a passenger train may be so timed that it has to traverse a portion that has not been patrolled during that long interval. In short, the patrolling as typified by these diagrams is entirely impersonal and makes no special provisions to protect passenger trains.

(ii) Night patrol system of a different type was formerly followed in the ex-Nizam's State Railway, the ex-Mysore State Railway and the ex-Madras & Southern Mahratta Railway. The main emphasis in this system was on positive coverage of all passenger trains. Typical rules governing the night patrol time-table under this system are:—

"(1) In drawing up patrol time-table, District Engineers will ensure that every train carrying passengers between 18.00 and 06.00 hours is effectively protected. Effective protection is given when the following conditions are satisfied:—

(a) The patrolman has reached that point of his beat where he exchanges books before a train or the first of a group of trains enters the patrolled section;

(b) The patrolman is on his way back to the station from which he started when the intermediate trains of a group enter the patrolled section;

(c) The patrolman has been back at the station from which he started not more than 10 minutes before the last train of a group of trains enters the patrolled section. Patrols may be slowed down by half-an-hour to fulfil this condition.

By a group of trains is meant those trains which pass over a patrolled section during the time a beat is in progress.

(2) It may happen that a beat is of such a length that certain portions are inspected by a patrolman some hours before a train passes over them. In such cases, at their discretion, having regard to *climatic conditions and the liability of the section to flood damage,* District Engineers may arrange for intermediate patrols or special watchmen."

(iii) These rules were specifically intended to protect every passenger train during hours of darkness. Moreover, no portion of the line is left unpatrolled for a long time before a passenger train passes over it. Where the patrol beats are long, it is likely that a stretch may be left unpatrolled for a long time. It is also likely that a passenger train may run over such a stretch under one of the sub-rules of Rule (1). In such cases, the District Engineers at their discretion should provide an additional patrol under Rule (2). By adopting this system of night patrol, the interval of time during which a portion of track remains unpatrolled before a passenger train, would be considerably reduced. It may not be possible to arrange patrols at such intervals as would eliminate all possibility of sudden floods remaining undetected. But it would considerably reduce the interval during which track remains unpatrolled before a passenger train and consequently the possibility of such a serious accident. This system of night patrol appears more suitable particularly on sections of the railway, subject to such dangerous conditions as sudden floods, land slips, boulder falls, etc. Suitable additional rules may be formulated to help the Engineers to determine what may be considered a long interval depending on the local conditions. The diagram given in Appendix VI will indicate clearly how better protection to passenger trains can be obtained under this system.

Protective measures at bridge No. 229

33. (i) The night patrol had been introduced on this section from the beginning of monsoon. The patrolmen had instructions to be

more vigilant at vulnerable bridges. Bridge No. 229 was classified as a vulnerable bridge. The patrol timings for Jadcherla-Mahbubnagar section are given in the patrol diagram, *vide* Appendix VII. According to this patrol diagram, patrolman No. 3 should pass bridge No. 229 at about 19.40, 22.20, 02.00 and 04.20 hours. There is evidence to show that on the night of the accident he had completed one round trip before the accident.

(ii) Bridge watchmen are provided at five groups of bridges between Jadcherla and Mahbubnagar. Each of these watchmen has to look after one group of vulnerable bridges. Bridge No. 229 at mile 66/15-16 and bridge No. 233 at mile 67/9-10 form one of these groups. Bridge No. 233 had been advised by the P.W.D. to be a tank affected bridge in accordance with the joint draft circular, *vide* Appendix II. The Permanent Way Inspector had found by local enquiries that bridge No. 229 was also tank affected. He had, therefore, arranged with the approval of the Divisional Engineer to keep this bridge under watch and had grouped it with bridge No. 233.

(iii) Bridge watchmen had been provided at vulnerable bridges during last two monsoons. In that period bridge watchmen had occasion to stop traffic on the Secunderabad division 61 times. The Permanent Way Inspector had travelled over Jadcherla-Mahbubnagar section on 6 nights since 1st August 1956 to check the presence and vigilance of the bridge watchmen and night patrolmen. On none of these occasions had he any cause to complain about the vigilance of his men. The movement of the bridge watchmen from one end of their beat to the other is not governed by any time-table. But they are expected to be always vigilant.

(iv) Bridge watchman, Bheemadu Naganna, who is in charge of bridge No. 229 has been bridge watchman or night patrolman for the last 15 years. He was the watchman on 1st August 1956 when the approaches of bridge No. 229 were washed away due to breach of Pochani Kunta. On that occasion, he had stopped a goods train that was approaching. On 1st September 1956, driver of No. 554 Up Express had noticed him at bridge No. 229. No. 554 Up passed this bridge at about 18.20 hours. Patrolman No. 3 had also seen him at bridge No. 229 both on his outward and return trips. Patrolman No. 3 has further deposed that this bridge watchman was at bridge No. 233 when he returned from mile 68/4. After the accident, gateman of Appanapalli gate met this bridge watchman on the P.W.D. road. The gangmate has deposed that at about 02.00 hours this bridge watchman came to the gang hut and woke him up with the news of the accident. I have, therefore, no doubt that the bridge watchmen and night patrolmen are generally vigilant; neither have I any doubt about the vigilance of this bridge watchman Bheemadu Naganna.

(v) From the evidence of this bridge watchman, it can be deduced that he normally comes on duty at about 18.00 hours at bridge No. 229. He leaves bridge No. 229 at about 20.00 hours, inspects bridge No. 233, takes a little rest at that bridge and returns to bridge No. 229 at about 21.00 hours. He follows more or less the same

procedure on his subsequent trips. He does the second trip between 23.00 and 00.30 hours; the third between 02.00 and 03.30 hours and the last between 04.30 and 06.00 hours. He has stated that he normally meets No. 565 Down passenger as he is approaching bridge No. 229 on the second trip. These rough timings of the bridge watchman are generally corroborated by the night patrolman No. 3.

(vi) Similar timings must have been observed on the day of the accident. Possibly, on this day, there was a delay of about 15 minutes before the bridge watchman returned to bridge No. 229 on the second trip. This delay appears to have been caused by the breaches. The night patrolman No. 3 should have reached the end of his beat after the first trip at 22.40 hours. According to his evidence, he had left his hut after about half-an-hour to one hour and proceeded to mile 68/4. On arrival, he observed red signal being exhibited from Mahbubnagar side. He exhibited danger signal towards Jadcherla and returned to ensure that the bridge watchman had protected the line. Allowing a few minutes for this patrolman at mile 68/4, he would be back at bridge No. 233 at about 00.15 hours. Allowing a few minutes for these two men to exchange intelligence, the bridge watchman would have left bridge No. 233 at about 00.20 hours. This would bring him within 4 telegraph posts of bridge No. 229 at the time of the crash. The watchman had stated that while approaching bridge No. 229, he was exhibiting danger signal. Possibly, this may be correct. A visibility test was conducted and it was found that a danger signal exhibited at the waist height by a watchman standing at the track level about 4 telegraph posts from bridge No. 229 on Mahbubnagar side was not visible from the engine, due to the curvature and cutting, till the engine crosses bridge No. 229 and travels a distance of about 200 feet beyond. Rough timings of movements of this bridge watchman and night patrolman No. 3 are shown in Appendix VII.

(vii) The weather warning telegram as received by the Permanent Way Inspector on 31st August night was "heavy rain in your area zones four and eighteen". There is evidence to show that the Permanent Way Inspector and the gangs have taken action on this telegram on the night of 31-8/1st September 1956. They had no warning regarding heavy rain for the night of 1/2nd September 1956. The weather warning telegram as received in the Control office at Secunderabad, however, was for the same zones, but it had mentioned the duration of the expected heavy rain as "next forty-eight hours". The Control office is expected to repeat the weather warning telegrams as received from the Meteorological Department according to para. 3 of the Central Railway Joint Engineering and Operating Departments' Circular No. 130, *vide* Appendix IV. In this case, there has been an omission in repeating the words "next forty-eight hours". During the period from 1st morning up to the time of the accident, there is evidence to show that there has been drizzle off and on, but there is no evidence regarding any heavy and prolonged rain, and even if the telegram had been repeated in full, there appears to be no reason for the gangs to be out patrolling. However, it is seen from the evidence of the mate that he had warned the Bridge Watchman near the gang huts to wake him up in case of heavy rain.

Water way at bridge No. 229

34. (i) This bridge was designed on the basis of Dicken's formula with C=800, and this flood discharge works out to:

$$Q = CA^{\frac{3}{4}}$$
$$= 800 \times 4{\cdot}37^{\frac{3}{4}}$$
$$= 2418$$
say, 2400 cusecs.

At this discharge the approximate depth of the flood water (including afflux) just up stream of the bridge as calculated by the Railway is 12.25′.

(ii) The discharge through the bridge, when the flood water upstream of the bridge just touches rail level is about 3,400 cusecs, as detailed below:—

Total discharge Q = discharge as an open large orifice (Q′) + discharge as submerged orifice (Q″)

Velocity of approach (approx.) = velocity in unobstructed stream (v_1) $\times$ $\frac{\text{depth in unobstructed stream (d)}}{\text{(depth d + afflux)}}$

$$= \frac{9{\cdot}80 \times 8{\cdot}10}{17{\cdot}25}$$
$$= 4{\cdot}60'/\text{Sec.}$$

Head due to velocity of approach. $= \frac{4{\cdot}60^2}{2g} = 0{\cdot}326$
Say $= 0{\cdot}33'$

$Q' = \frac{2}{3} \times C_d \times \sqrt{2g} \times B[(H + h_a)^{1{\cdot}5} - (h + h_a)^{1{\cdot}5}]$

Where C_d = coeff. of discharge = say 0·60
B = width between abutment = 19·2′
H = difference between tail water level and rail level = 9·15′
h = difference between rail level and bottom of girder = 2·67′
h_a = head due to velocity of approach = 0·33

i.e., $Q' = \frac{2}{3} \times 0{\cdot}60 \times \sqrt{64{\cdot}4} \times 19{\cdot}2\ [(9{\cdot}15+0{\cdot}33)^{1{\cdot}5} - (2{\cdot}67 + 0{\cdot}33)^{1{\cdot}5}]$

$$= 61{\cdot}7\ [9{\cdot}48^{1{\cdot}5} - 3{\cdot}00^{1{\cdot}5}]$$
$$= 61{\cdot}7 \times 24{\cdot}0,$$
Q' = 1480 cusecs

$Q'' = C_d \times A \times \sqrt{2g}\ [(H + h_a)^{0{\cdot}5} - h_a\ 0{\cdot}5]$

When C_d = Coeff. of discharge = 0·60
A = Area of orifice = tail water depth × width between abutments = 8·10 × 19·2′
H = Difference between tail water level and rail level = 9·15
h_a = Head due to velocity of approach = 0·33

i.e., $Q'' = 0{\cdot}60 \times 8{\cdot}10 \times 19{\cdot}2 \times \sqrt{64{\cdot}4}\ [(9{\cdot}15 + 0{\cdot}33)^{0{\cdot}5} - 0{\cdot}33^{0{\cdot}5}]$

$$= 750\ [\sqrt{9{\cdot}48} - \sqrt{0{\cdot}33}]$$
$$= 750 \times 2{\cdot}53$$
$$= 1900 \text{ cusecs.}$$

Total discharge through bridge Q = 1480 + 1900 cusecs.
$$= 3380$$
Say = 3400 cusecs.

Therefore, for any flood discharge in excess of 3,400 cusecs, the water will overtop the bridge and cause erosion of the bridge approaches.

(a) Tank breach on 1st August 1956

35. (i) The Permanent Way Inspector had trollied over this bridge at about 13.00 hours. On arrival at Mahbubnagar at 13.40 hours, he was informed that Pochani Kunta had breached and water had topped bridge No. 229. He immediately returned arriving at the bridge at 14.25 hours. On arrival, he found that both the approaches of the bridge had been washed away but the water level had gone down to about 3 feet from the floor level.

(ii) The peak discharge on that day can be calculated from the flood marks that can be seen on the banks at a cross-section about 2,000 feet up-stream from the railway bridge.

(iii) Assuming the rail level on the inner rail at bridge No. 228, as 100, the highest water level at this cross-section was found to be 118.49.

Area of the cross-section — A = 804 sq. ft.

Coefficient of rugocity for moorum bed and sinuous curves. — n = 0·03

Hydraulic mean depth at the cross-section. — R = 4·58 ft.

Local slope 6·35 feet in 1000 — S = 0·0064

Coefficient of discharge as calculated by Kutters formula. — C = 64·4

Velocity—V $= C\sqrt{RS}$

$= 64{\cdot}4 \times \sqrt{4{\cdot}58} \times 0{\cdot}0064$

$= 11{\cdot}04$ ft. per sec.

$Q = AV$

$= 804 \times 11{\cdot}04$

$= 8890$

= say, 8900 cusecs.

(iv) The level of water over the road surface at the road bridge situated 1,600′ down-stream from the railway bridge, on this day, as advised by the Chief Engineer, P.W.D. (R. & B.) Hyderabad, was 2·86′. The flood discharge calculated from this water level is about 8,700 cusecs. This discharge agrees closely with the flood discharge, computed from cross sections 2,000′ up-stream.

(v) On 1st August 1956, it is found from flood marks at the railway bridge that the water level has reached up to 101·84 *i.e.*, 2·94′ above rail level. With 2·94′ water over the rail level, and assuming that no breach in the approach embankments took place, the flood discharge is calculated approximately at 7,000 cusecs.

But as seen from sub-paras. (iii) and (iv) above the flood discharge on 1st August 1956, is known to be about 8,900 cusecs. Therefore, it is clear that the approach embankments on either side must have breached before the water overtopped the rails.

(b) Washaway of bridge approaches on 1/2nd September 1956

(i) The examination of the site showed that both approaches of bridge No. 229 have been washed away. This can only happen if

there is scour of the bank on the down-stream side and possibly subsidence. The scour of the bank can be started only if the water overtops the banks. Once the water has topped the bank it would start scouring from the down-stream side particularly as the wings are sloping. This would be aggravated by possible seepage of the water through the newly formed bank, which can take place particularly when there is heavy afflux.

(ii) The approximate value of the flood discharge on 1/2nd September 1956, can be calculated from the level of water over the P.W.D. road. The level of water as advised by the Chief Engineer, P.W.D., (R. & B.), Hyderabad, is 2·36′. With this depth of water over the road, the flood discharge, calculated by the Railway is approximately 6,100 cusecs. This discharge is more than what the bridge (No. 229) can pass without topping of the track, as seen from para. 34.

(iii) I inspected Pochani Kunta and the catchment area of this Nala on the 4th. On that day it was seen that most of the water that was flowing was being brought by the right hand channel in the catchment from the right hand valley. This evidently was the regenerated water from the catchment. The catchment area is thickly wooded and the possible run off appears to be about 70 per cent. There is evidence of local villagers of Kakarlapahad and Thigalapalli, to show that there was unprecedented rain between 22.00 hours and 00.00 hours in that area. These villages are near the apex of the right hand valley on the watershed line. Assuming that the cloud burst occurred only on the right hand valley in the catchment, the effective area of the catchment is approximately 2·74 sq. miles. The precipitation of rain that may be necessary to obtain the maximum discharge that may have passed through the bridge can be found by using Cochran's formula.

Cochran's formula for discharge from a small catchment is:

$$q = 1100\ C\ I/I + \frac{0{\cdot}85\sqrt{ML}}{VZ}$$

where q = maximum flood per sq. mile of catchment

$$= \frac{6100}{2{\cdot}74} = 2230 \text{ cusecs.}$$

C = Coefficient of run-off = 0·70
I = Precipitation in inches per hour.
M = Catchment area in sq. miles = 2·74
L = Ratio of length to mean width of catchment area

$$= \frac{13000}{5800} = 2{\cdot}24$$

V = Velocity of flood travel $= \frac{v}{1{\cdot}47f}$

(v = 10′ per sec. in this case
f = sinuosity factor
= 1·5 in this case)

$$= \frac{10}{1{\cdot}47 \times 1{\cdot}5}$$

$$= 4{\cdot}4$$

Z = Ratio of maximum width to average width of catchment.

$$= \frac{8000}{5800} = 1{\cdot}38$$

$$1100 \times 0{\cdot}7 \times I/1 + 0{\cdot}85 \frac{\sqrt{2{\cdot}74 \times 2{\cdot}24}}{4{\cdot}4 \times 1{\cdot}38} = q = 2230$$

$$\therefore 2230 = 770\ I/1 + \frac{0{\cdot}85\sqrt{6{\cdot}137}}{6{\cdot}07}$$

$$\therefore I = \frac{2230 \times 1{\cdot}347}{770}$$

$$\therefore I = 3{\cdot}9 \text{ inches per hour.}$$

Therefore, the intensity of precipitation on 1/2nd September 1956 may have been about 4" in one hour.

(iv) In the opinion of Dr. P. R. Pisharoti of the Meteorological Department rainfall of such a precipitation is quite possible at any place in India.

(v) According to the evidence of the watchman, he left this bridge at 23.00 hours. The accident has occurred at 00.39 hours. This means that the water level has risen from about 4'-6" above the floor level to over the rail level and has dropped to 4' below the rail level at the time of the accident. All this has taken place in about one hour and 40 minutes. Whether this is possible or not will depend on several factors such as duration, distribution and intensity of rainfall. None of these factors are definitely known but in the opinion of the Director, Central Water and Power Research Station, Poona, it is possible to arrive at some conclusions based on the article on Flood Hydrographs by G. G. Commons. In cases of floods having a single peak, the rate of rise is about one-and-a-half times as rapid as the rate of fall. The same article gives a method of constructing and evaluating a hydrograph for such conditions where the peak discharge, catchment area and rainfall intensity are the only known factors.

(vi) From evidence it is clear that heavy rainfall in the catchment continued for about 2 hours. In the opinion of Dr. P. R. Pisharoti, 6" of rainfall can occur in 2 hours. On this assumption the build up to the peak of the flood can take place in about 60 minutes. The flood can drop to 2200 cusecs (corresponding approximately to water level to 8' below rail level) in about 40 minutes thereafter, *i.e.* the rise and fall in this case can occur in 100 minutes. This was the period during which the bridge watchman was away from bridge No. 229.

Sequence of events

36. (i) At the time of the accident, the train was travelling at about 30 miles per hour or 44 feet per second. The distance the engine has travelled from the beginning of the scoured embankment till it came to rest is less than 100 feet. Considering the speed of the train, the accident probably took place in less than about 5 seconds. During such a short time interval, it is not possible for various events to impress themselves on anybody's mind. It has, therefore, not been possible to obtain direct evidence as to what actually occurred.

(ii) An attempt at reconstructing the probable sequence of events can, however, be made by examination of the Wreckage and other available evidence. Before the train approached the site, the flood was receding and the erosion of the bank must have progressed

considerably. The erosion was probably not very pronounced at the end but was progressively more and more severe till near the abutment, the bank was completely scoured to a considerable depth. As soon as the front pony wheels of the engine came on the affected portion, the track yielded and the front two wheels derailed to the right travelling tangentially to the curve. The steel sleepers, over which these travelled, show light marks of derailment indicating that they were not properly supported. While the first pony wheels were travelling in the derailed condition slight guiding action along the curve was probably imparted to the engine by the other pony wheels and the driving wheels. After the engine proceeded a few feet further, it is possible that the second pony wheel also derailed and travelled a distance of a few sleeper lengths as is evident from two marks of derailment on a few trough sleepers. These marks are also very light indicating very slight support. The jaws of sleepers opened out and the sleepers dropped off. Almost simultaneously the fish plates on the Jadcherla approach snapped. The front end of the engine continued falling in the scoured portion behind the abutment. The engine must have covered a distance of 25 feet before approaching the abutment in slightly over half-a-second and during that period it has apparently fallen downwards through a distance of about 4 feet indicating that it was falling without much support. This also indicates that the erosion at least upto that depth of the bank had already taken place near the abutment. This assumption receives further support from the absolute absence of any marks on the recovered crib sleepers.

(iii) The buffer plate of the engine shows a deep vertical score mark. The examination of the bridge masonry indicates that if the buffer had hit the abutment behind the ballast wall it may not have damaged the abutments as much as it did. It would probably have broken the ballast wall and may have crashed into the girder and damaged the bridge sleepers. The absence of damage to the bridge sleepers and the absence of damage to the left hand girder indicates that they never came in contact with the engine. For this to happen the buffer must have crashed into the bridge approximately at the top of the bed block level, *i.e.*, it must have fallen through a distance of about 4 feet. The engine was in working order with the reciprocating parts of the driving gear in motion. At the moment it hit the abutment the engine must have, therefore, acted as a pneumatic hammer. Immediately it crashed into the back of the abutment, high compressive forces must have been induced in the girder for an instant before the masonry of both the abutments crumbled due to the hammering action of the engine. The compressive forces induced in the girders caused the girders to buckle momentarily. These forces along with a couple induced in these girders, almost immediately, caused the connecting diaphragms to shear from both the girders. The anchor bolts holding the left hand girder must have at that instant broken free from the masonry. The impact of the engine also induced forward motion into the girders and as the left hand girder was free it must have been shot forward. The right hand girder was probably held for an infinitesimal instant longer as can be seen by the bend on its Mahbubnagar end bearing plate. This lag of time induced a couple in the girders imparting a slight rotary motion to the left hand girder, which was found

thrown across the track pointing to the right. The presence of this couple is further corroborated by the breakage of the outstanding legs of the inside stiffener angle at the trailing end and of the outside stiffener angle at the leading end. Tilting motion was probably induced in the right hand girder as it was prevented, for an instant by the bearing plate, from being thrown forward. With the tilting, the girder must have also started to fall. Possibly, during the fall, it was supported partially by the crumbling masonry of the abutments. Simultaneously, the hook bolts holding the sleepers must have been forced backwards and all the sleepers thrown clear on the Mahbubnagar side embankment while the left hand girder was shot forward. This should have happened a fraction of a second before the engine came on to the bridge.

(iv) An instant later, the engine must have come on to the right hand girder. Engine must have then travelled on the flanges of the right hand girder as it was falling partially supported by the crumbling masonry. During this instant, the engine was travelling along the tangent of the curve, *i.e.*, towards the right hand end of the Mahbubnagar side abutment. This is corroborated by complete demolition of the upstream wing as compared with the partial one of the downstream wing of this abutment. It then must have crashed into the Mahbubnagar side abutment. At that time the support it had obtained from the girder may have checked its fall and imparted to the front end a slight upward motion. Lack of deep dents on the pony wheels appear to corroborate the slight upward motion of the front end. While crashing through the Jadcherla end abutment the right side wind cutter plate of the Engine has been torn indicating that the gap in the masonry was probably of the width of the bed blocks. As soon as the pony wheels passed through this gap, the middle driving wheels (flangeless), the rear driving wheels, the hind truck and the front trolly wheels of the tender must have demolished the masonry of the Mahbubnagar end abutment by successive blows. All these wheels show deep dents with particles of masonry deeply imbedded in them. By striking against the masonry, the hind truck of the engine became detached and dropped on the bed just inside the Mahbubnagar end abutment. This was carried downstream and was later found buried under the sand beyond the return wall. The front bogie of the tender also got detached and was found lying between the abutments resting against the Mahbubnagar end abutment. It is possible that the front end of the engine was at a slightly lower level than it was finally found. The embankment at this place is hard moorum almost approaching soft rock. The momentum of the train may have caused the front end to slightly lift on the inclined plane formed by the scoured bank. The first two bogies telescoped and were thrown out completing the demolition of the Jadcherla end abutment and wings.

(v) After the crash, there is no indication of water level going up. It is possible that for a few minutes the water level was stationary indicating that whatever heading up took place due to the obstruction was compensated by the fall in the flood discharge. The water has rushed into the cab of the engine and risen upto the neck of the driver who was standing on the foot-plate. The foot-plate was 8 feet below the rail level indicating that water level at that instant was probably 4 feet below the rail level. The impact

of the engine may have induced compressive forces of very high intensity in the rails also and broken them in a number of pieces of varying lengths from 1'-6" upwards. Two pieces of rails which remained connected with the track at Mahbubnagar end were probably lifted up and forced over by the engine.

Design and alignment of the bridge (No. 229)

37. (i) The bridge was designed for discharge on Dickens's formula, $CA^{\frac{3}{4}}$, assuming the constant to be 800. This formula was in use at the time of construction all over the ex-N.S. Railway. This formula gives the discharge values at a low figure compared with the more recent Inglis's formula but this was the formula which was approved and used extensively in India at that time. The waterway provided, based on this formula, is quite adequate for ordinary rainfall. The highest flood recorded in this bridge so far has been only 2'-11" above floor level. The waterway based on this formula, however, does not cater for occasional cloud bursts that occur at infrequent intervals. The waterway at this bridge consequently, proved inadequate for high flood caused by the cloud burst of 1/2 September 1956.

(ii) The bridge is sited a little distance from the place where the Nala takes a right hand turn. The stream impinges the embankment at a slight angle. As long as the discharge was of a low magnitude, no adverse effect was noticed. When discharges of large magnitude and high velocity occur, water always tries to follow a straight course. Such large discharges occurred at this bridge on 1st August 1956 due to the breach of Pochani Kunta and again on 1/2nd September 1956 due to cloud burst. On both these occasions, the main attack of water was behind Jadcherla and abutment. Possibly, there were eddies formed behind Mahbubnagar end abutment and consequent scour. It would have been advisable to have sited this bridge a few hundred feet further downstream where the course of the Nala is straight.

Remedial measure

38. (i) It would be advisable to provide a bridge at a new site on the straight portion of the Nala. This would necessitate considerable alteration to the alignment for a long stretch and possibly re-siting of other bridges. It would, therefore, necessarily be a very expensive remedial measure. The other alternative is to design the waterway based on the maximum possible discharge from the catchment given by Inglis's formula, $7000A/\sqrt{A+4}$, *i.e.*, approximately 11,000 cusecs. Incidentally, the discharge obtained from Cocharan's formula for this catchment at 4" an hour precipitation is approximately 10,000 cusecs. To cater for this discharge, the waterway will have to be increased to 60 Lft. and the headway increased by about 2 feet.

(ii) The discharge based on this formula, however, is very high and normally it should be enough if waterway is provided for a discharge based on the modified Inglis's formula, $4000A/\sqrt{A+4}$. For this discharge, the water-way required would be 40 Lft. with existing headway.

(iii) If waterway is provided based on the lower value, it would be necessary to protect the top and both up and downstream sides of embankment by stone pitching to prevent erosion or washaway of the bank on those rare occasions when the extreme floods occur.

Design of bridges in general

39. (i) During the last 7 years, there have been at least six major accidents on the Indian Railways due to washaway of the bridge approaches or scours of the bridge foundations. All these accidents have caused heavy loss of life. For each of these accidents, undoubtedly, there have been at least a few narrow escapes. The main reason for these accidents appears to be inadequate waterway and consequent over-topping of the bank and resultant erosion and scour. No doubt, the bridges were designed and built on discharge values obtained by Dickens's or Ryve's or any other formula that was then in use. The accidents indicate that bridges so designed do not provide adequate waterway for occasional cloud bursts that occur, though at infrequent intervals.

(ii) The recent observations and analysis of data conducted by Sir Claude Inglis and Shri D. V. Joglekar have proved that the likely flood discharges in India could be of the value obtained by Sir Claude Inglis's formula, $7000A/\sqrt{A+4}$. This formula gives the discharge values at a very high figure, but is the only one that has so far proved to be absolutely safe. It is now being used for designing various works more and more often throughout India. A few important works designed on this formula in recent times are:—

(a) Kakarpara project on Tapti river;

(b) Cross drainage works in Hirakud project;

(c) Spillway of Gandhi Sarovar near Ajmer.

(iii) In recommending this formula, Sir Claude Inglis has stated:—

> "The only way to decide this question is by judgment, based on past experience and records but in examining this, one point of importance should be borne in mind—maximum storms tend to occur more frequently in medium sized catchments than in very large ones.
>
> In deciding what maximum flood to allow for judgment must be used as to whether a risk may be taken or not.
>
> No flood, which is greatly in excess of Inglis's fan catchment formula will occur under Indian conditions but larger floods have been recorded in an area of abnormal floods in the United States of America.
>
> The fact that no storm of the magnitude shown by this formula had been recorded in, say 100 years, does not show that such a storm may not occur at rare intervals."

Considering the serious accidents that have occurred the remarks quoted above deserve serious consideration.

(iv) The Inglis's formula quoted above was modified by the author where favourable conditions exist. Under such circumstances, the formula recommended is $4000A/\sqrt{A+4}$. Actually, the first formula is obtained from an enveloping curve of the maximum discharges observed while the latter is obtained from a mean curve for the same discharges. Based even on this formula, the discharge values obtained are much higher than those used for designing most of the railway bridges in years gone by.

(v) The serious accidents that have occurred indicate that the waterway of all bridges have to be re-checked. It also appears unavoidable that waterway of all bridges be increased to make them absolutely safe under flood conditions indicated by Sir Claude Inglis's formula. When the waterway provided is based on the formula, $4000A/\sqrt{A+4}$ it is essential to provide pitching on both the upstream and downstream side approaches as well as on top.

(vi) Incidentally, it will be advisable to remove the flooring and drop walls where provided. The flooring and drop walls induce a false sense of security particularly when provided at bridges over streams having erodable beds. Under flood conditions, the drop wall acts as weir and induces heavier scours on the downstream side. While providing enlarged waterways, sufficiently deep founds may also be provided and flooring and drop walls eliminated. It would be advisable to provide pitching around the piers where it is not possible to provide sufficiently deep foundations.

(vii) Examination of the adequacy of waterways and adoption of remedial measures at all bridges on the Indian Railways is no doubt a question of vast magnitude. In the absence of any other infallible method of ensuring safety, there appears to be no alternative. It is admittedly impossible to tackle all bridges simultaneously but the work can be suitably phased, based on extent of catchment as indicated below:—

(a) All bridges having a catchment of 700 sq. miles and above can be omitted. Discharge values obtained by Sir Claude Inglis's formula and those obtained by the older formulae for catchments in excess of 700 sq. miles are more or less compatible.

(b) All bridges having a catchment area from 2 to 50 sq. miles should be considered as bridges having medium sized catchments and, therefore, subject to high floods more often. These should be considered first. In the opinion of Dr. Pisharoti of the Meteorological department, a cloud burst can occur over an area covered by one cumulus cloud, *i.e.* approximately 25 sq. miles. Therefore, considering catchments upto 50 sq. miles as medium sized should provide an adequate margin of safety.

(c) Bridges having either larger or smaller catchments can be dealt with after the bridges having medium-sized catchments.

(viii) Bridges in each group can be further sub-divided for the purpose of allotting priorities on other considerations such as:—

(a) Bridges having past history should be given top priority.

(b) The bridges in the same area or situated in areas having similar features such as hilly catchments, steep bed slopes, etc., where the streams are subject to quick run offs and sudden spates may be considered next.

(c) The remaining bridges being considered in due course.

(ix) In cases where provision of adequate waterway or other remedial measures cannot be expeditiously implemented, constant watch should be kept during rainy season.

Coincidences

40. (i) In the accident, there has been a very curious coincidence. Mr. Srihari, the President of the Local Labour Union at Mahbubnagar, had stopped No. 566 Up Passenger the night before, because there was heavy rainfall at Mahbubnagar. He asserted that he was aware of the defects of bridge No. 229 and had, therefore, stopped that train. After stoppages of the train, six trains have passed safely over this bridge at normal speed. The reason he has given for considering this bridge unsafe is that he was a water-boy when this bridge was repaired some years ago and, therefore, knew that the construction was defective. No repairs have been done to this bridge during the last few years, as a matter of fact, since it was built. Mr. Srihari's contention, therefore, is not tenable. His action in stopping No. 566 Up on 1st September 1956 at about 2.30 hours and this accident can only be considered as one of those coincidences which sometimes occur.

(ii) Another remarkable coincidence is that, a flood of an intensity unknown in 40 years should have occurred within a month of the tank breach, a breach which rendered the bridge non-vulnerable.

Adequacy and promptness of relief measures

41. (i) Once the news of the accident reached Mahbubnagar, the relief measures were adequate and prompt. In fact, they could hardly be improved upon. The only question that remains to be examined in this connection is whether there was any avoidable loss of time in conveying the news.

(ii) The news of the accident was brought to Mahbubnagar by a passenger on his bicycle which was loaded in the luggage van. He volunteered to convey the news and also brought to the notice of the guard the existence of his bicycle in the brakevan. If the guard had displayed any initiative, he should have, on his own, made use of this bicycle and conveyed the news through one of the many railway personnel who were available on the train. This would have brought the news to Mahbubnagar about one hour earlier.

(iii) The news of the accident was taken to Appanapalli village and conveyed to a local landlord by the son of a gateman after a delay of about an hour. This village is about 200 yards from the level crossing gate or within a walking distance of 15 minutes from the site of the accident. If the guard had made inquiries regarding the nearest village from the gateman, who came to the site almost immediately and sent the message about the accident, it would

certainly have reached Mahbubnagar much earlier. Here again, the guard had shown complete lack of initiative.

(iv) Another person who had an opportunity of conveying the information quickly was the bridge watchman. From the position where he was, he had almost a ring side seat at the crash. He should have promptly turned round and conveyed the news to Mahbubnagar. His excuse that there were breaches towards Mahbubnagar is at best an afterthought. He could easily have reached Mahbubnagar by the P.W.D. road which he took to go in the other direction. Apparently, seeing the crash, he lost his nerves.

(v) There has been a delay of about 20 minutes on the part of the Assistant Station Master, Mahbubnagar, in sending the information to the local officials and if the Permanent Way Inspector had not sent word immediately the message was received, the relief operations may have been delayed a little more. The Permanent Way Inspector's action in sending the message and in arranging for the conveyance of the medical relief equipment has been commendably prompt.

(vi) This accident again brings forcibly home the necessity to provide portable telephones on passenger trains.

(vii) The medical relief equipment was brought from Mahbubnagar to the site by road. This was based at the level crossing gate at mile 66/8. The rescued persons were sent to this base to receive medical aid. The 'C' class medical relief equipment is stored in 8 or 9 heavy boxes and, therefore, could not be carried nearer to the site of the accident than the level crossing gate. The medical aid at the level crossing had to be rendered in open in rainy weather. It would be advisable to include a small tent in this class of equipment to afford shelter while medical aid is being given. This would not materially affect the mobility of the equipment. It would also help if 6 haversacks containing first aid kit are included in this class equipment to make it more mobile and consequently more useful.

(viii) At the time of the accident it was pitch dark. If any light could have been provided, it is possible that a few lives might have been saved. If the accident site could have been lit up by a powerful beam, persons being carried away by the current might have been able to grasp at vantage points or it may have been possible to throw a rope to them and thus a few might have been rescued. To light up the accident site in such emergencies, it would be advisable to devise a lamp, which can be fixed on a telescopic tripod stand, worked from the storage batteries of the carriages. Even if such lighting can be done for a short time, considerable advantage may be derived. It would also be an advantage to provide suitable lengths of ropes in the accident tool kit of brakevan, which can be used in such emergencies.

(ix) Apart from the question whether there has been delay or not in obtaining medical relief the circumstances of the accident were such that with the most prompt relief arrangements, no better results could have been achieved. The tremendous fury of the torrential flood had probably done all the damage to life and property within a few minutes of the crash.

Possibility of anybody being in a position to prevent the accident

42. (i) The possibility of the driver being in a position to avert the accident has already been discussed and eliminated under the question of "Head lights".

(ii) About 15 minutes before the accident, gateman Balliah, seems to have heard the roar of rushing water. He states that he spoke about it to the off-duty gateman, Nagaiah. Nagaiah denies that such a discussion took place. His denial is unbelievable as the conversation had been heard by the third gateman's son, Ramuloo. The reason, as stated to have been given by Nagaiah to Balliah, is that as Pochani Kunta had already breached and, therefore, there was no danger to be apprehended at bridge No. 229. It is possible that Nagaiah may quite reasonably have given this as an excuse for not going to the bridge at mid-night. The reason given by him is also quite rational and, therefore, he cannot be blamed for not taking action about an event which probably occurs once in a century. However, he had an opportunity, to prevent the accident, that was lost.

(iii) The weather warning telegram received from the Meteorological Centres on the afternoon of 31st August was "scattered heavy rains likely zones three and four next fortyeight hours". Similar telegram covering the same period was also received with respect to zones eighteen and ninteen by the Secunderabad Controller. These four zones cover the entire Secunderabad Division excluding Secunderabad-Kazipet and Bonakalu-Balharshah sections. The Control Office conveyed this information to all concerned without mentioning the duration indicated in the weather warning telegram received from the Meteorological office.

The rainfall during the few days prior to the accident at Mahbubnagar as recorded in the Executive Engineer's Office (R&B) and as recorded at Mahbubnagar station during the 24 hours ending at about 8.00 A.M. are as follows:—

Date	Rainfall as recorded in the PWD Executive Engineer's Office.	Rainfall as recorded in Mahbubnagar station.*
28-8-56	00·00	00·00
29-8-56	00·00	00·20
30-8-56	00·05	00·00
31-8-56	00·19	00·00
1-9-56	02·71	03·05
2-9-56	01·60	01·65

*NOTE.—These figures, as recorded in the rainfall register maintained at the station, are for one day in advance of the date mentioned in this paragraph. This is due to a misunderstanding on the part of the ASM regarding how the rainfall should be recorded and therefore had to be ante-dated by one day.

The P.W.D. Executive Engineer's (R&B) Office is approximately one mile towards the East of Mahbubnagar. From the evidence it appears that the rainfall at the gang hut at Mile 65/6 and at Mahbubnagar on the night of 1/2nd September 1956 has been moderate and that the cloud burst was entirely confined to the hills. It is, therefore, likely that even if the gangs had received the warning, they may not have gone out on patrol, but the possibility of their having gone out and patrolled the line cannot be altogether omitted. To that extent, therefore, the Controller has failed to take action required of him by the instructions contained in the Joint Circular No. 130.

(iv) There was a lot of thunder and lightning in the hills. The bridge watchman for bridge No. 229, night patrolman No. 3, bridge watchman for bridge No. 235, have all noticed this thunder and lightning. All of them anticipated that there would be some trouble between miles 68/1-13 which actually occurred. Night patrolman No. 3 proceeded during his rest period for nearly ¾ of a mile beyond his beat and observed danger signal exhibited by the bridge watchman at mile 68/7. He, in his turn, exhibited the danger signal towards Jadcherla side and was returning to protect the track. The danger signal exhibited by this man was observed by bridge watchman at bridge No. 233. This bridge watchman protected the line and waited for the night patrolman to arrive to find out what had occurred. This probably delayed his departure to bridge No. 229 by those vital 15 minutes, which prevented him from protecting No. 565 Down passenger from crash.

(v) Considering all the circumstances, it is evident that nobody can be blamed for not preventing the unfortunate accident.

V. CONCLUSIONS

Cause of the accident

43. (i) It has been found that the condition of the engine and rolling stock was good. None of them was overdue P.O.H. There were no defects either in the engine or the rolling stock which could have either caused or contributed to the accident.

(ii) The maintenance of the track generally on this section is excellent. The approaches of this bridge had been attended to by the gang on 12 occasions during one month before the accident. During the same period, it has been inspected by the Permanent Way Inspector 17 times, by the Assistant Engineer 7 times and by the Divisional Engineer twice. None of them has noted any defects at the bridge approaches. The track has also been tested by the Hallade Track Recorder twice and on both occasions no defects have been recorded at the bridge or its approaches. I, therefore, consider the track could not have either caused or contributed to the accident.

(iii) The bridge structure was completely examined by the Divisional Engineer, Assistant Engineer and the Permanent Way Inspector after the washaway on 1st August 1956. All of them noted no structural defects. Even the pointing was intact. There is no evidence of scour. The bridge structure, therefore, could not have caused or contributed to the accident.

(iv) There was erosion and subsidence of the bridge approaches caused by the sudden cloud burst that occurred in the catchment of Pochani Nala. I, therefore, consider the cause of the accident to be erosion and subsidence of the Jadcherla approach of bridge No. 229.

Responsibility

44. (i) (a) The bridge was designed according to the practice obtaining on H.E.H. the Nizam's State Railway then.

(b) The water level in this bridge had never risen above 2'-11" from the floor level and, therefore, there was no reason to suspect the adequacy of the waterway.

(c) The rainfall in the catchment area was abnormally heavy and sudden.

(d) The vulnerability of this bridge had been removed by the breach of Pochani Kunta one month earlier.

(ii) All the precautions that human ingenuity could think of had been taken but nature can always outwit human ingenuity and this occasion is one such.

(iii) I, therefore, do not hold anyone responsible for the accident.

Relief Measures

45. The relief measures were prompt and adequate under the circumstances.

Yours faithfully,

C. R. SULE,

Government Inspector of Railways.

BOMBAY;

6*th December*, 1956.